SEN00161-29

Shop Manual

ENGINE

107E -1 SERIES

ecot3

KOMATSU

Engine

107E-1 Series

00 Index and foreword

Foreword and general information

Handling of electric equipment and hydraulic component

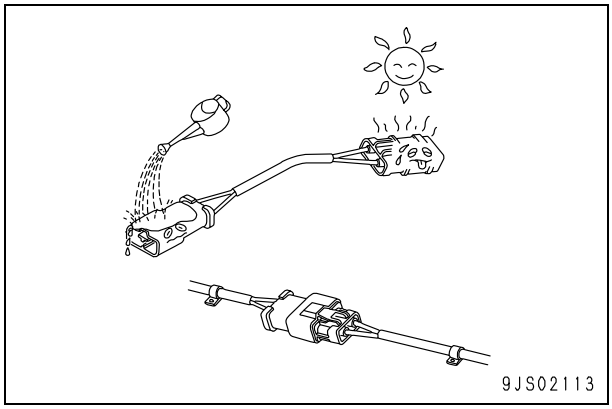
To maintain the performance of the machine over a long period, and to prevent failures or other troubles before they occur, correct “operation“, “maintenance and inspection“, “troubleshooting“, and “repairs” must be carried out. This section deals particularly with correct repair procedures for mechatronics and is aimed at improving the quality of repairs. For this purpose, it gives sections on “Handling electric equipment” and “Handling hydraulic equipment” (particularly gear oil and hydraulic oil).

Points to remember when handling electric equipment

1. Handling wiring harnesses and connectors

Wiring harnesses consist of wiring connecting one component to another component, connectors used for connecting and disconnecting one wire from another wire, and protectors or tubes used for protecting the wiring.

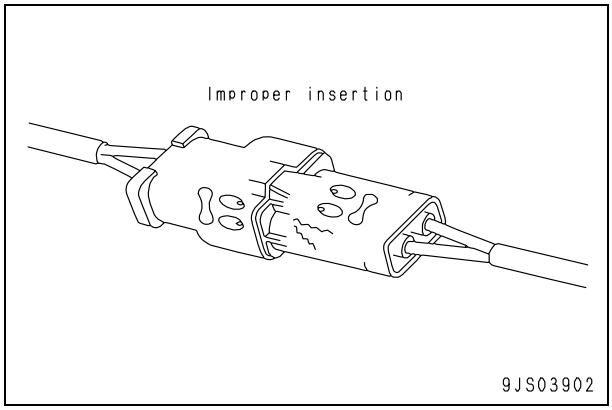
Compared with other electrical components fitted in boxes or cases, wiring harnesses are more likely to be affected by the direct effects of rain, water, heat, or vibration. Furthermore, during inspection and repair operations, they are frequently removed and installed again, so they are likely to suffer deformation or damage. For this reason, it is necessary to be extremely careful when handling wiring harnesses.



2. Main failures occurring in wiring harness

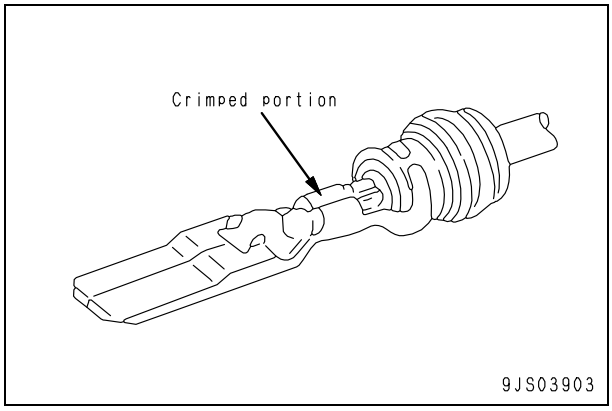
1) Defective contact of connectors (defective contact between male and female)

Problems with defective contact are likely to occur because the male connector is not properly inserted into the female connector, or because one or both of the connectors is deformed or the position is not correctly aligned, or because there is corrosion or oxidization of the contact surfaces. The corroded or oxidized contact surfaces may become shiny again (and contact may become normal) by connecting and disconnecting the connector about 10 times.



2) Defective crimping or soldering of connectors

The pins of the male and female connectors are in contact at the crimped terminal or soldered portion, but if there is excessive force brought to bear on the wiring, the plating at the joint will peel and cause improper connection or breakage.



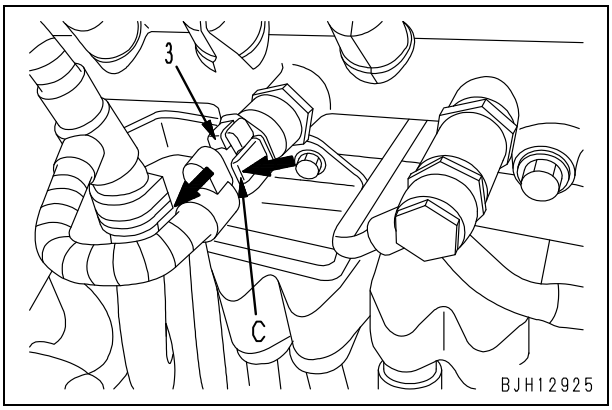
3. Push lock type

- 95, 107, 114 engines
  Example)
  Fuel pressure sensor in common rail
  (**BOSCH-03**)

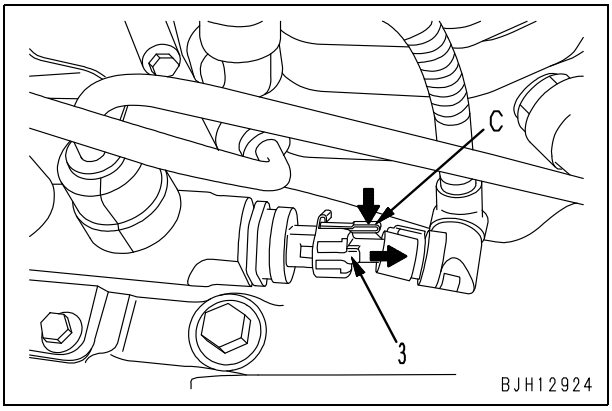
Disconnect connector (3) according to the following procedure.

1) While pressing lock (C), pull out connector (3) in the direction of the arrow.

- 114 engine

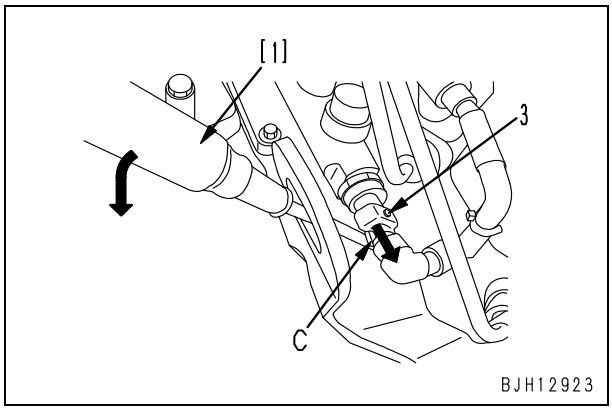


- 107 engine



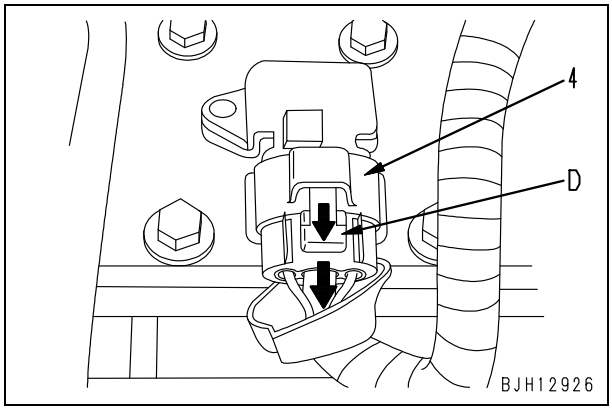
★ If the lock is on the underside, use flat-head screwdriver [1] since you cannot insert your fingers.

2) While pressing up lock (C) of the connector with flat-head screwdriver [1], pull out connector (3) in the direction of the arrow.



- 107, 114 engines
  Example)
  Intake air pressure/temperature sensor in intake manifold
  (**SUMITOMO-04**)

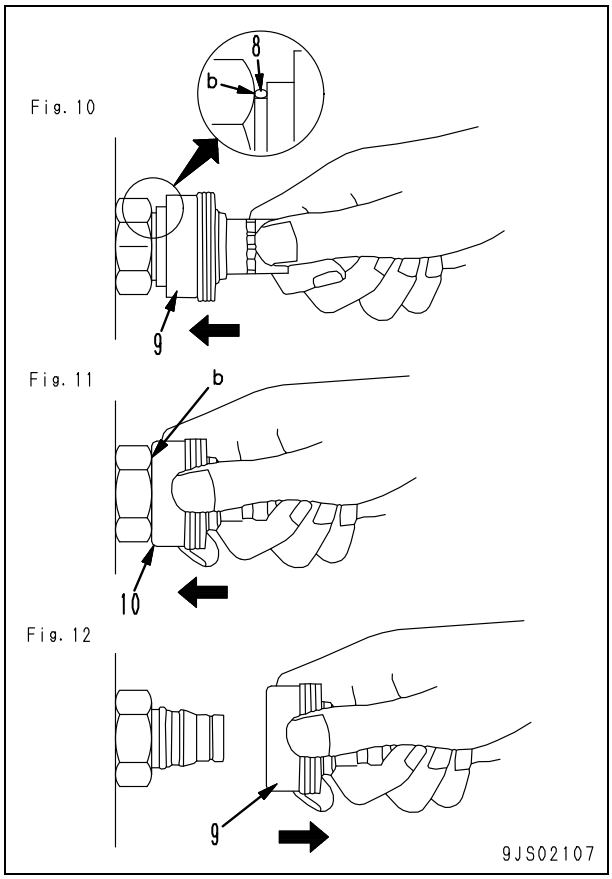
3) While pressing lock (D), pull out connector (4) in the direction of the arrow.



Type 3

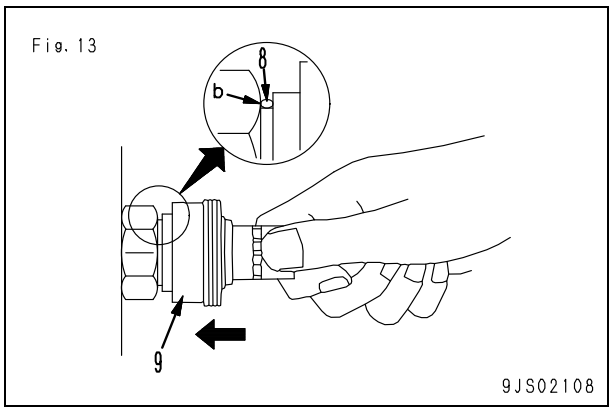
1. Disconnection

1) Hold the tightening portion and push body (9) straight until sliding prevention ring (8) contacts contact surface (b) of the hexagonal portion at the male end. (Fig. 10)
2) While holding the condition of Step 1), push cover (10) straight until it contacts contact surface (b) of the hexagonal portion at the male end. (Fig. 11)
3) While holding the condition of Steps 1) and 2), pull out whole body (9) to disconnect it. (Fig. 12)



2. Connection

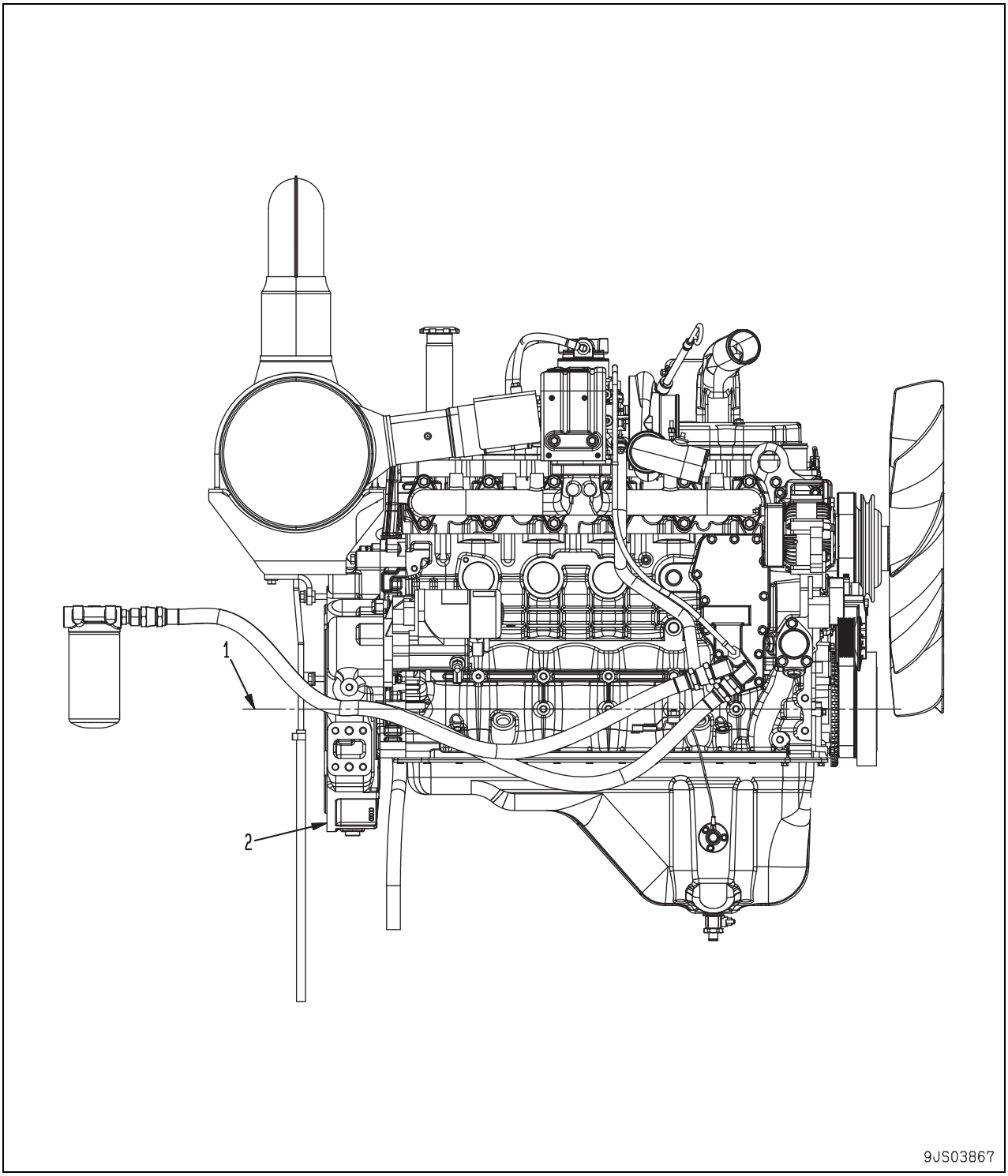
- Hold the tightening portion and push body (9) straight until the sliding prevention ring contacts contact surface (b) of the hexagonal portion at the male end. (Fig. 13)



Engine			SAA6D107E-1
Applicable model			PC228US-3E0, PC228USLC-3E0
No. of cylinders – Bore × Stroke		mm	6 – 107 × 124
Total piston displacement		ℓ {cc}	6.69 {6,690}
Firing order		—	1–5–3–6–2–4
Dimensions	Overall length	mm	1,355
	Overall width	mm	790
	Overall height (excluding exhaust pipe)	mm	—
	Overall height (including exhaust pipe)	mm	1,409
Performance	Rated horsepower	kW{HP}/ min^{-1}{rpm}	116 {155}/2,000{2,000} (Gross)
	Max. torque	Nm{kgm}/ min^{-1}{rpm}	624 {63.6}/1,500{1,500} (Gross)
	Max. speed with no load (High idle speed)	min^{-1}{rpm}	2,060 ± 50{2,060 ± 50}
	Min. speed with no load (Low idle speed)	min^{-1}{rpm}	1,050 ± 25{1,050 ± 25}
	Fuel consumption ratio at rated point	g/kWh {g/HPh}	223 {166}
Dry weight		kg	553
Fuel injection system		—	HPCR
Fuel injection system control			Electronic control type
Lubricating oil amount (refill capacity)		ℓ	25.4 (23.1)
Coolant amount		ℓ	8.4
Alternator		—	24V, 35A
Starting motor		—	24V, 4.5kW, 5.5kW
Battery		—	12V, 110Ah × 2
Turbocharger		—	HOLSET HX35
Air compressor		—	—
Others		—	—

Engine			SAA6D107E-1
Applicable model			A6D107E-GD-1
No. of cylinders – Bore × Stroke		mm	6 – 107 × 124
Total piston displacement		ℓ {cc}	6.69 {6,690}
Firing order		—	1–5–3–6–2–4
Dimensions	Overall length	mm	1,501
	Overall width	mm	764
	Overall height (excluding exhaust pipe)	mm	—
	Overall height (including exhaust pipe)	mm	1,254
Performance	50Hz rated horsepower	kW{HP}/ min^{-1}{rpm}	115 {155}/1,500{1,500} (Gross)
	60Hz rated horsepower	Nm{kgm}/ min^{-1}{rpm}	139 {186}/1,800{1,800} (Gross)
	Max. speed with no load (High idle speed)	min^{-1}{rpm}	Max. 1,890{Max. 1,890}
	Min. speed with no load (Low idle speed)	min^{-1}{rpm}	650 ± 25{650 ± 25}
	Fuel consumption ratio at rated point (50 Hz/60 Hz)	g/kWh {g/HPh}	221/223 {165/166}
Dry weight		kg	675
Fuel injection system		—	HPCR
Fuel injection system control			Electronic control type
Lubricating oil amount (refill capacity)		ℓ	25.4 (23.1)
Coolant amount		ℓ	8.4
Alternator		—	24V, 35A
Starting motor		—	24V, 4.5kW
Battery		—	12V, 100Ah × 2
Turbocharger		—	HOLSET HX35W
Air compressor		—	—
Others		—	—

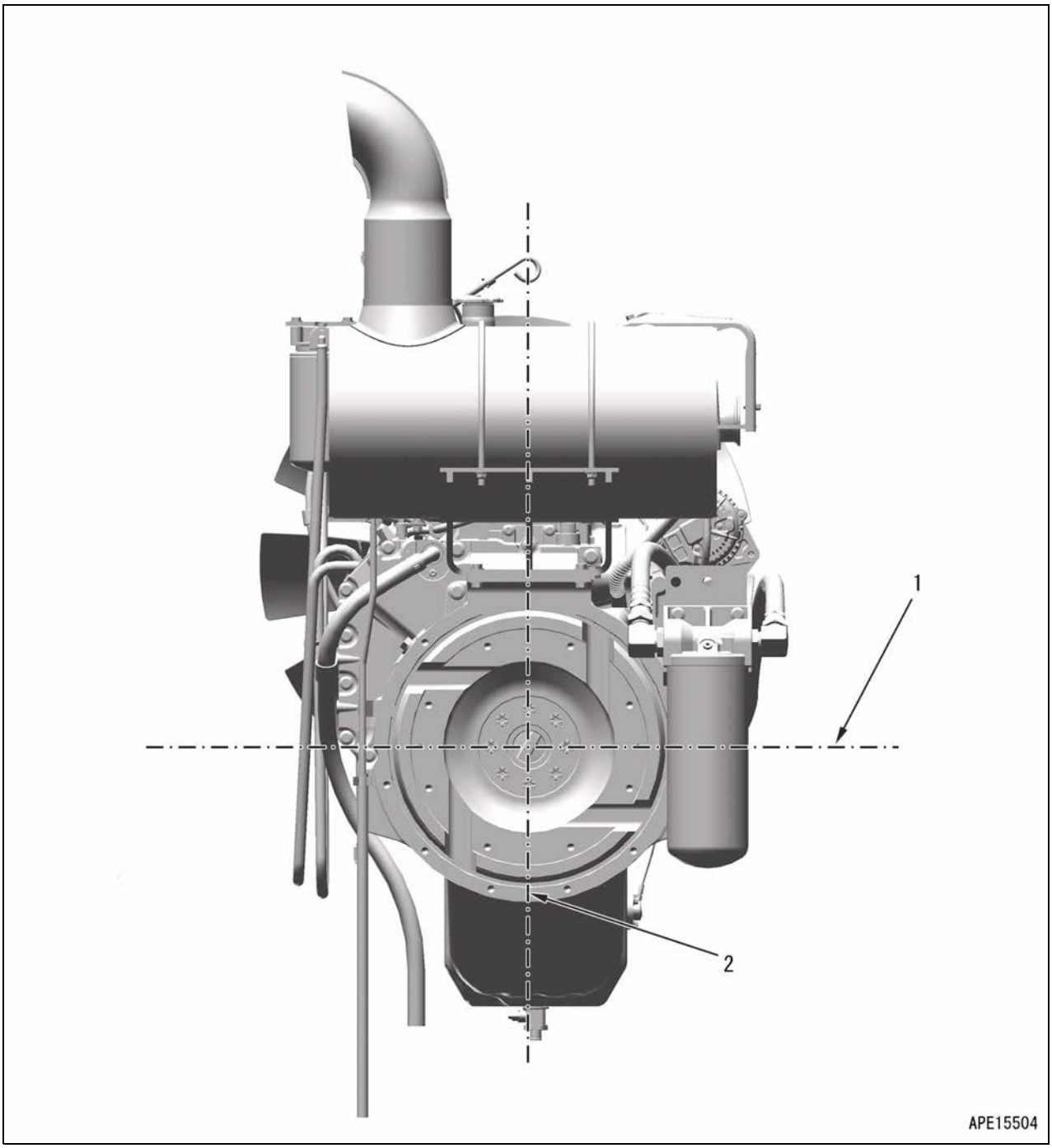
SAA6D107E-1 (Right side view of engine)
Machine model: PC200-8, PC200LC-8,PC220-8, PC228US-3E0, PC228US-8, PC228USLC-8, PC270-8, BR380JG-1E0



★ The shape may differ according to the machine model.

1. Crankshaft center
2. Flywheel housing rear surface

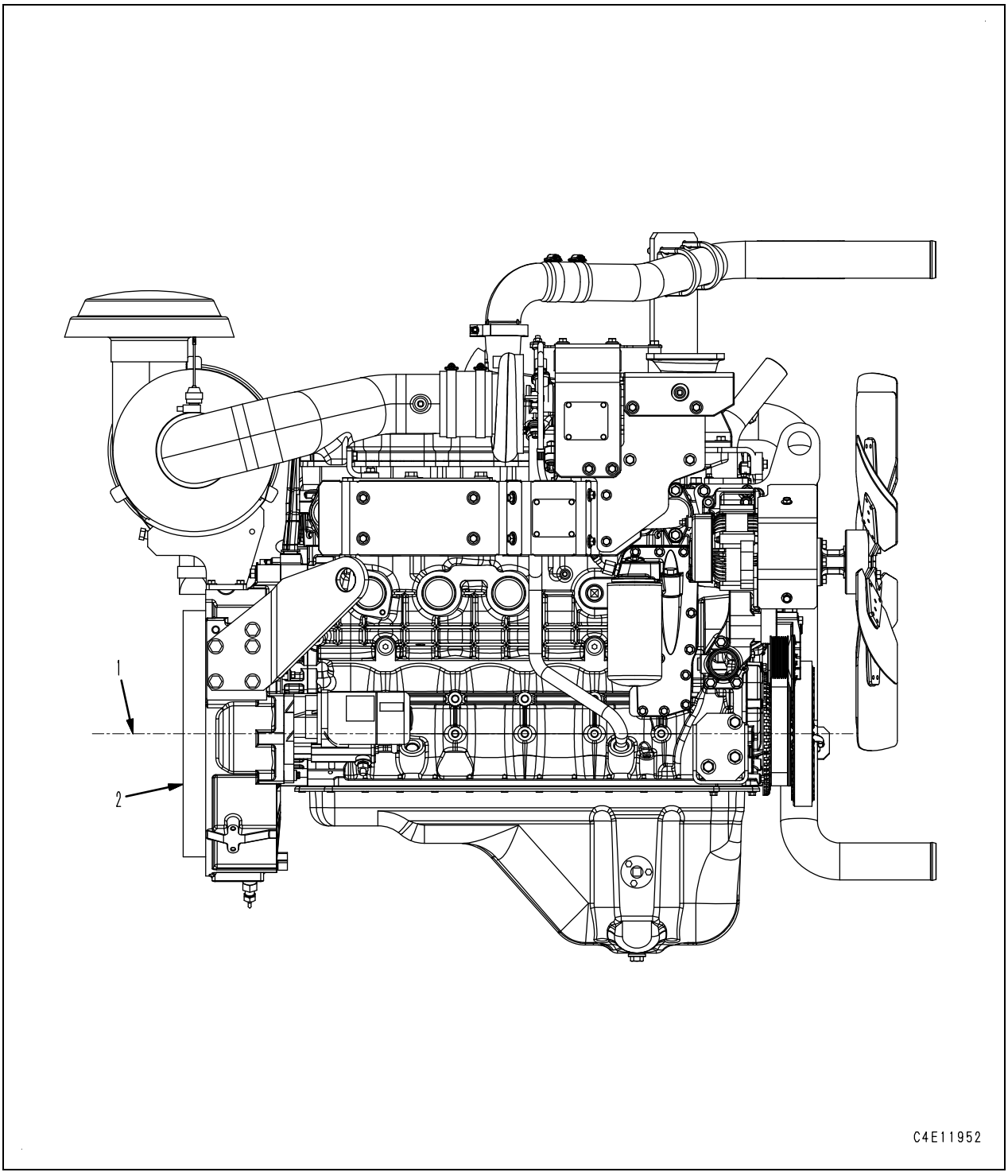
SAA6D107E-1 (Rear view of engine)
Machine model:
PC210-10M0, PC210LC-10M0



★ The shape may differ according to the machine model.

1. Crankshaft center
2. Cylinder center

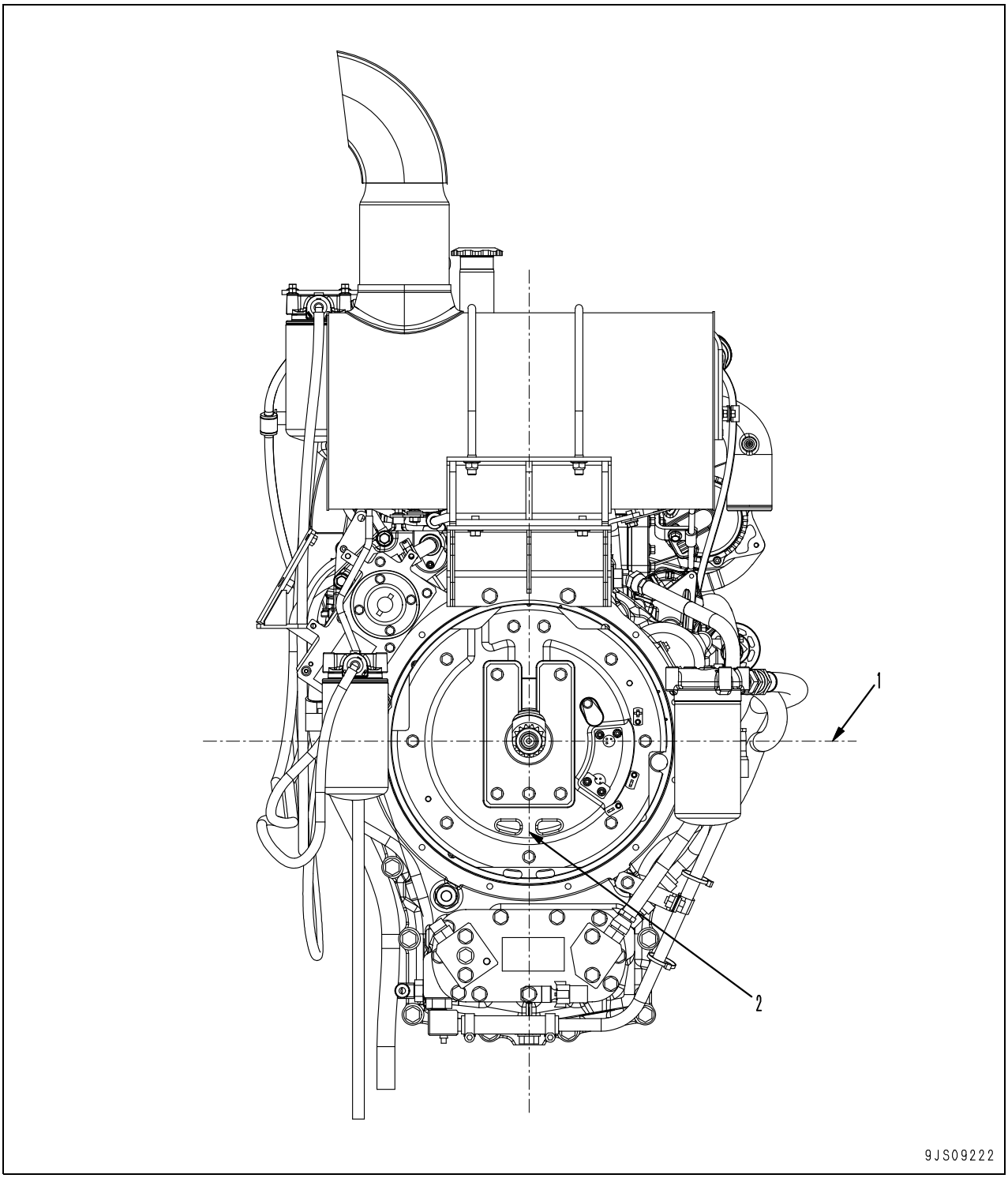
SAA6D107E-1 (Right side view of engine)
Machine model: A6D107E-GD-1 (Portable generator)



★ The shape may differ according to the machine model.

1. Crankshaft center
2. Flywheel rear surface

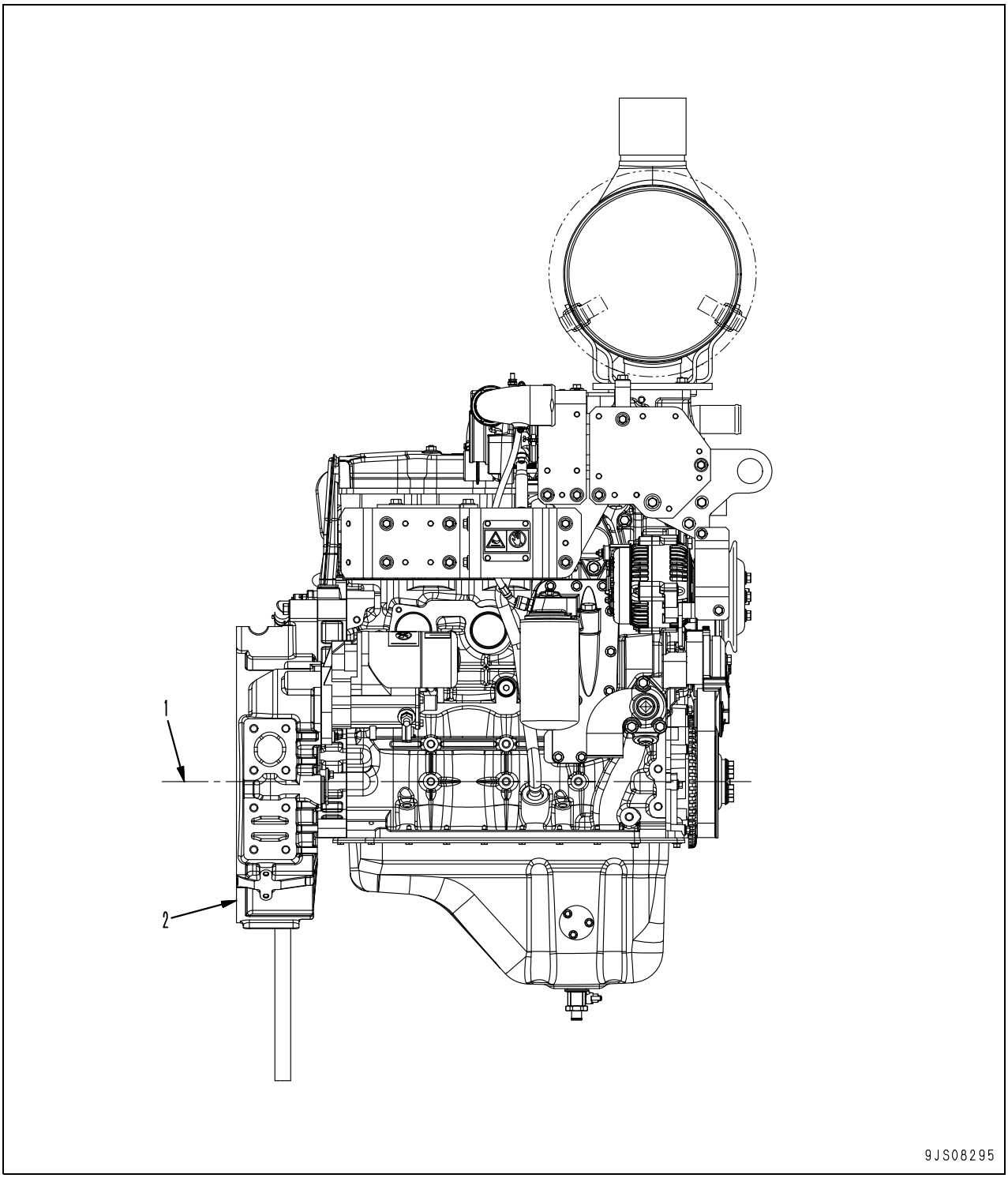
SAA4D107E-1 (Rear view of engine)
Machine model: PC200LC-8E0



★ The shape may differ according to the machine model.

1. Crankshaft center
2. Cylinder center

SAA4D107E-1 (Right side view of engine)
Machine model: WA200-6,WA200PZ-6

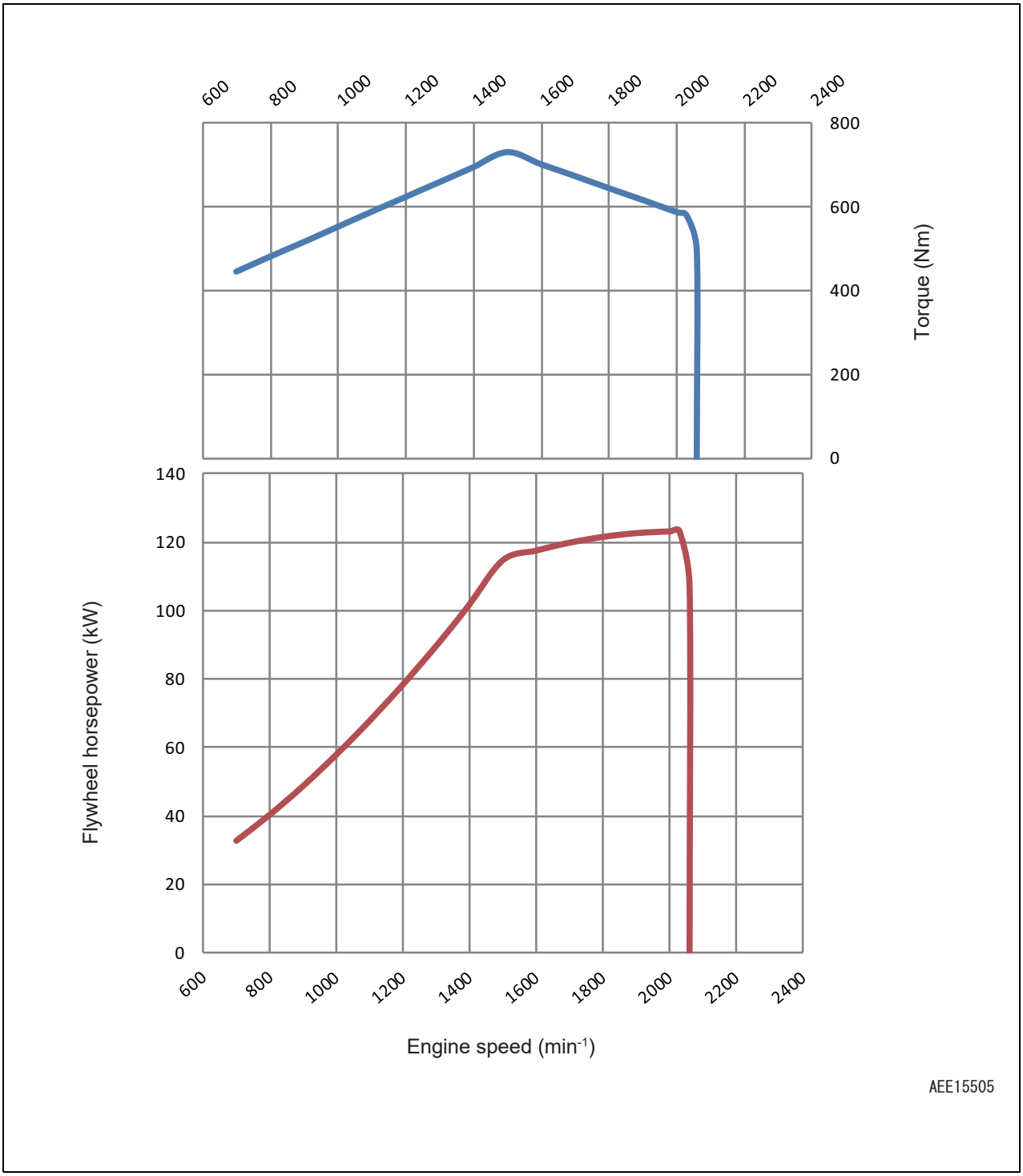


★ The shape may differ according to the machine model.

1. Crankshaft center
2. Flywheel housing rear surface

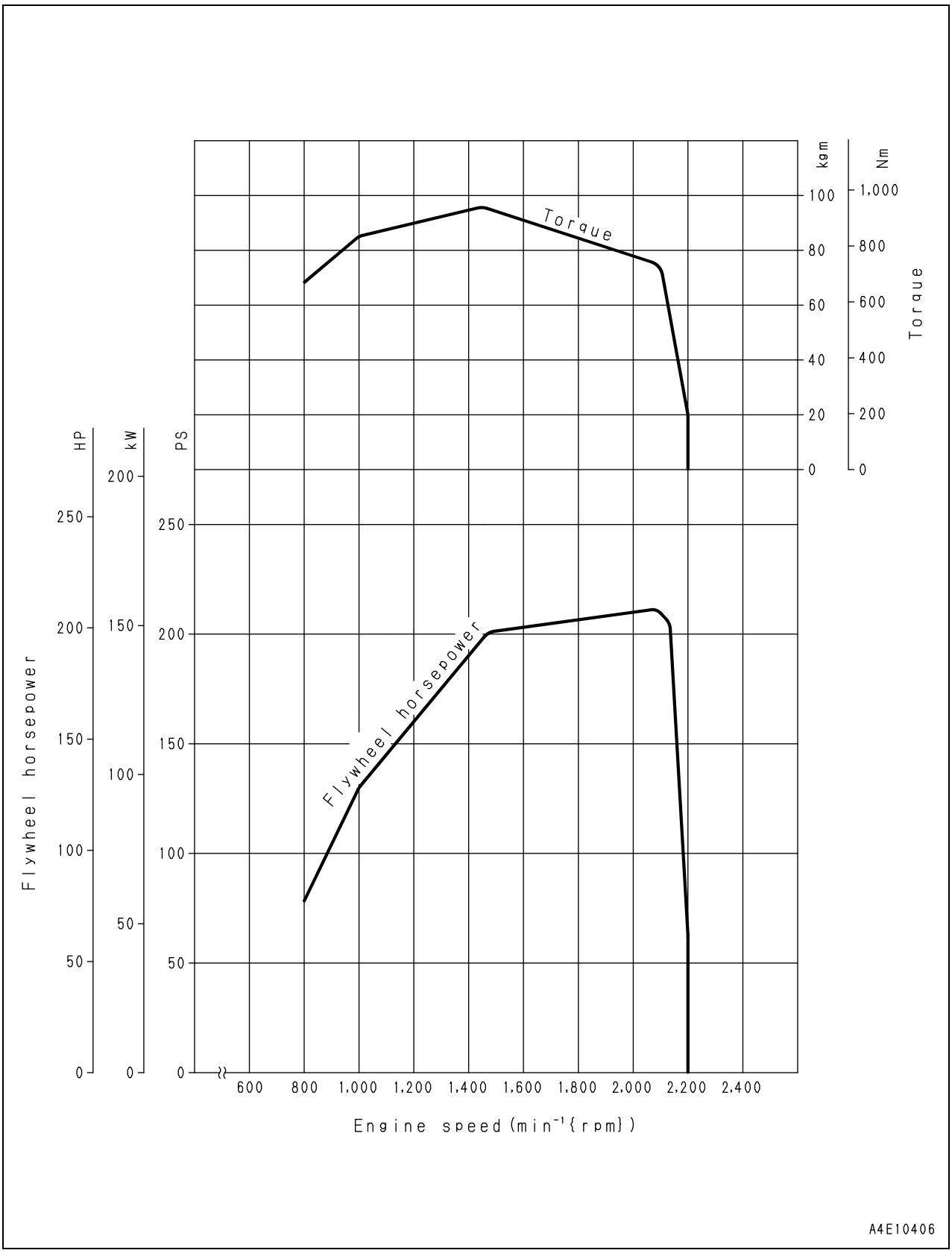
SAA6D107E-1 (Machine model: PC210-10M0, PC210LC-10M0)

Rated horsepower: 123.2 kW {165 HP}/2,000 min^{-1}{2,000 rpm}(Gross)
Max. torque:731 Nm {74.5 kgm}/1,500 min^{-1}{1,500 rpm}(Gross)



SAA6D107E-1 (Machine model: GD655-5, GD675-5)

Rated horsepower: 164.8 kW {221 HP}/2,100 min^{-1}{2,100 rpm} (Gross)
Max. torque: 941 Nm {96.0 kgm}/1,450 min^{-1}{1,450 rpm} (Gross)



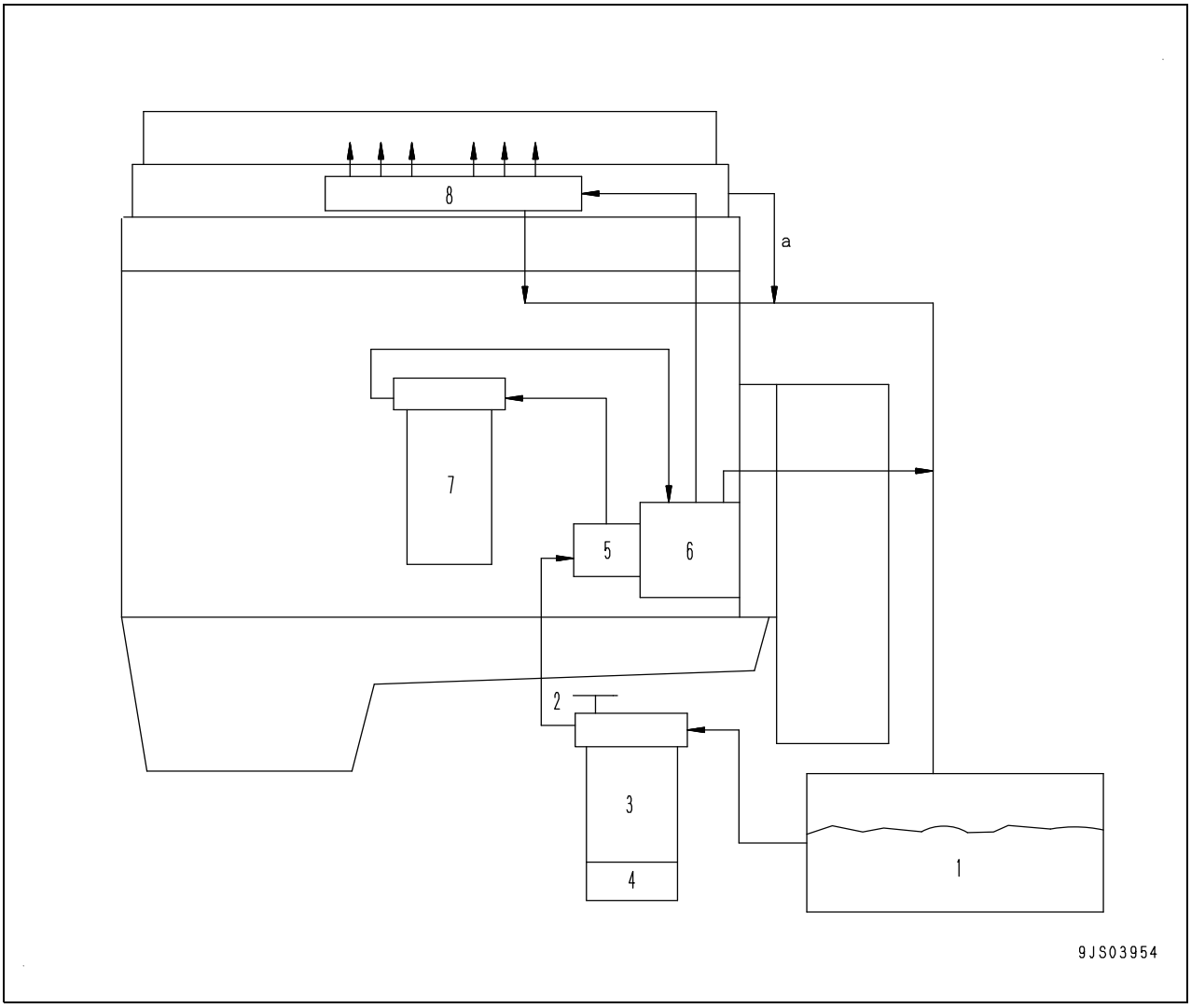
Engine

107E-1 Series

10 Structure, function and maintenance standard

Fuel system

General Information (Flow Diagram)



1. Fuel supply tank
2. Hand primer
3. Prefilter (water/fuel separator)

★ not mounted on engine

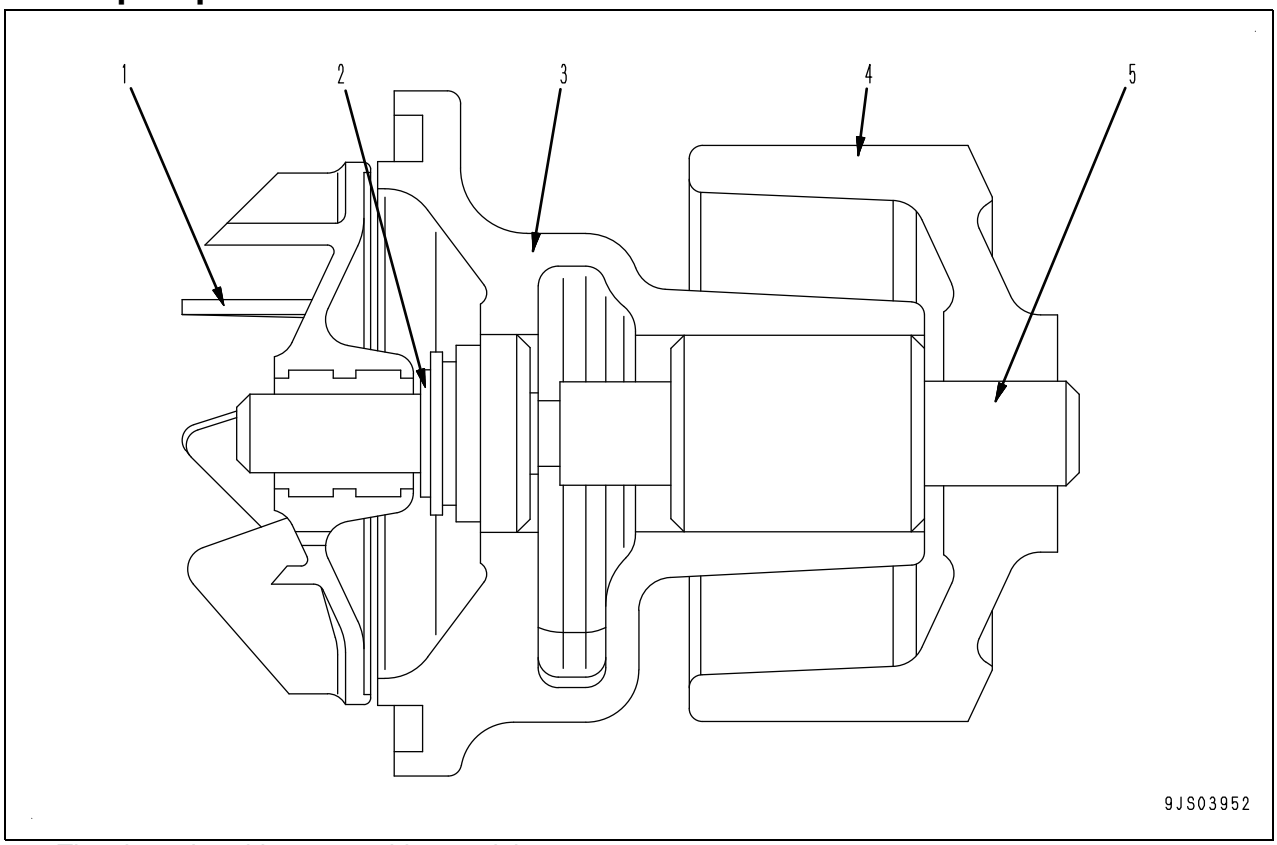
4. Clear bowl
5. Gear pump (low pressure fuel pump)
6. Fuel supply pump (high-pressure fuel pump)
7. Fuel main filter
8. Fuel rail (common rail)

a: Injector drain

Unit: mm

No.	Check item	Criteria		Remedy
1	Strain of cylinder head mounting face	End-to-End	Max. 0.075	Correct by grinding or replace
		Side-to-Side	Max. 0.075	
2	Diameter of main bearing metal mounting hole	87.982 to 88.008		Replace main bearing metal cap
3	Inside diameter of main bearing metal	83.041 to 83.109		Replace bearing metal
4	Thickness of main bearing metal	2.456 to 2.464		
5	Diameter of cam bushing mounting hole	Max.: 59.248		Correct or replace block
6	Inside diameter of cam bushing	Max.: 54.164		Replace cam bushing
7	Tightening torque for main cap mounting bolt (Apply engine oil to threads)	Procedure	Target (Nm {kgm})	Tighten and retighten
		1st stage	60 {6.1}	
		2nd stage	80 {8.2}	
		3rd stage	Retighten 90 degrees	
8	Tightening torque for oil pan mounting bolt	Target (Nm {kgm})		Tighten
		28 {2.8}		
9	Tightening torque for crankshaft pulley mounting bolt	Procedure	Target (Nm {kgm})	
		1st stage	50 {5.1}	
		2nd stage	Rotate 90 degrees clockwise	
10	Inside diameter of cylinder	106.990 to 107.010		Correct by oversize or replace cylinder block
	Roundness of inside of cylinder	Repair limit: 0.038		
	Taper of inside of cylinder	Repair limit: 0.076		

Water pump



★ The shape is subject to machine models.

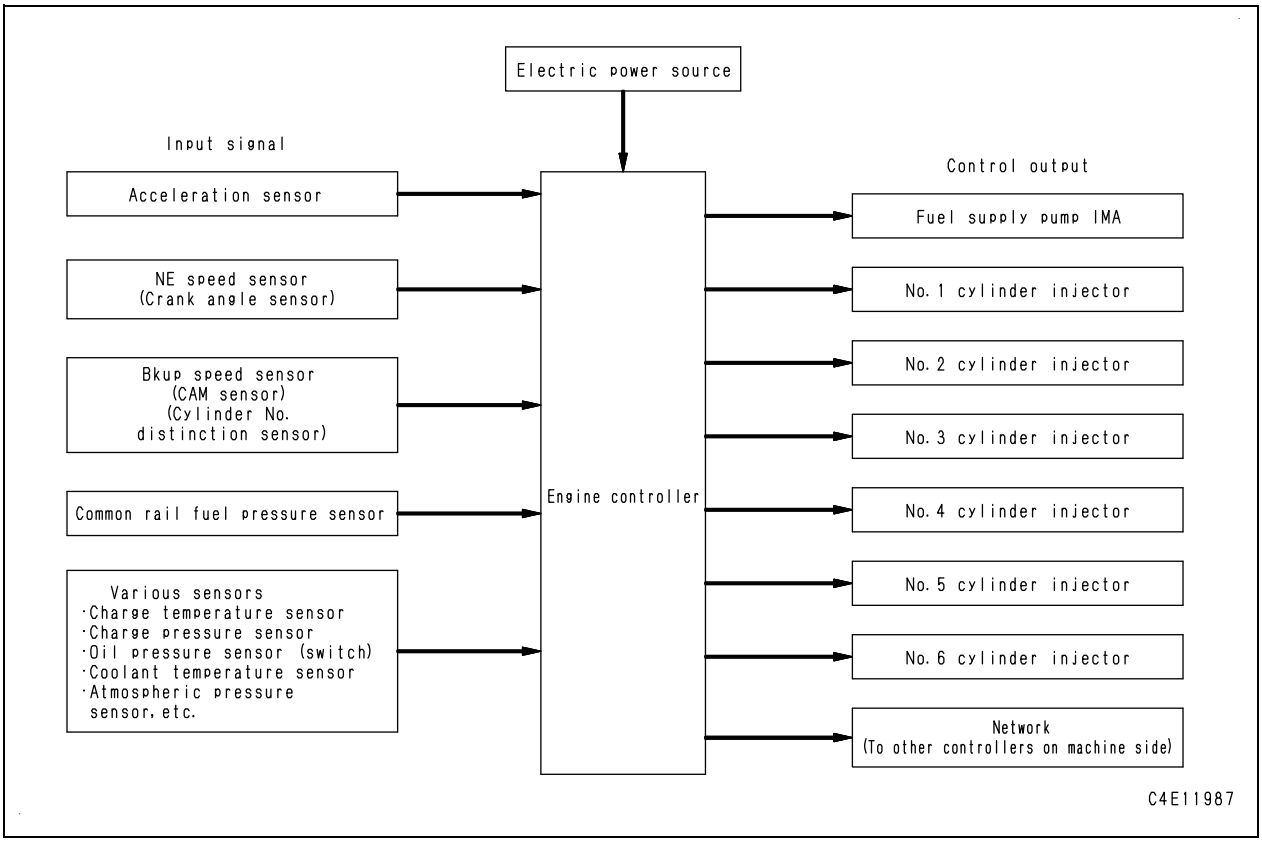
1. Impeller
2. Water seal
3. Pump body
4. Pulley
5. Drive shaft

Specification

Type: centrifugal type, poly V-belt drive

Engine	Applicable machines	Type	Specification	Number of pinion teeth	Weight (kg)
SAA6D107E-1	PC200-8M0 PC200LC-8M0 PC210-10M0 PC210LC-10M0 PC220-8M0 PC220LC-8M0 PC240LC-8M0 PC228US-3E0 PC228USLC-3E0 PC228US-8 PC228USLC-8 PC308USLC-3E0 WA380-6 WA380Z-6 BR380JG-1E0 GD655-5 GD675-5	Drip proof, oil proof type, manufactured by DENSO	24 V, 5.5 kW	10	10.5
SAA4D107E-1	PC160LC-7E0 PC160LC-8 PC200-8E0 PC200LC-8E0 HB205-1 HB215LC-1 HB205-1M0 HB215LC-1M0 D39EX-22 D39PX-22				

Control system



- The CRI* system checks the condition of the engine (engine speed, accelerator angle, coolant temperature, etc.) with sensors.
- The engine controller of the CRI system controls the fuel injection rate, fuel injection timing, fuel injection pressure, etc. totally to operate the engine under the best condition.
- The CRI system has a diagnosis function which engine controller checks the main component parts and notifies the operator of detected failures.
- In addition, the CRI system has a failsafe function which stops the engine when a certain parts fail and a backup function which continues the operation by changing the control method in such a case.
  *: CRI means common rail injection.

Engine

107E-1 Series

20 Standard value table
Standard service value table

Engine				SAA6D107E-1	
Applicable machine				WA250-6, WA250PZ-6	
Cate-gory	Item	Measurement conditions	Unit	Standard value for new machine	Repair limit
Performance	Engine speed	Max. speed with no load	rpm	2,250 ± 50	2,250 ± 50
		Min. speed with no load	rpm	825 ± 25	825 ± 25
	Necessary starting speed	At 0°C	rpm	—	—
		At –20°C	rpm	—	—
Air intake and exhaust system	Intake resistance	At all speed	kPa {mmH2O}	Max. 3.73 {Max. 380}	7.45 {760}
	Intake pressure (Aftercooler inlet)	At rated horsepower	kPa {mmHg}	Min. 120 {Min. 900}	93 {700}
	Exhaust pressure (Turbine inlet press.)	At rated horsepower	kPa {mmHg}	—	—
	Exhaust temperature (Turbine outlet temp.)	At all speed (at 20°C)	°C	Max. 650	700
	Exhaust gas color	At rated horsepower	Opacity %	Max. 12	22
		Quick acceleration (Low idle → high idle)	Opacity %	Max. 25	35
	Valve clearance	Intake valve	mm	0.25	0.152 to 0.381
		Exhaust valve	mm	0.51	0.381 to 0.762
Body	Compression pressure	Oil temperature: 40 to 60°C Engine speed: 250 to 280 rpm	MPa {kg/cm2}	Min. 2.41 {Min. 24.6}	1.69 {17.2}
	Blowby pressure	At rated horsepower	kPa {mmH2O}	Max. 0.98 {Max. 100}	1.96 {200}
Lubrication system	Oil pressure	At rated horsepower (Oil temperature: Min. 80°C) SAE15W-40	MPa {kg/cm2}	Min. 0.29 {Min. 3.0}	0.25 {2.5}
		At low idle (Oil temperature: Min. 80°C) SAE15W-40	MPa {kg/cm2}	Min. 0.10 {Min. 1.0}	0.07 {0.7}
	Oil temperature	At all speed (Oil in oil pan)	°C	80 to 110	120
	Oil consumption ratio	At continuous rated horse-power (Ratio to fuel consumption)	%	Max. 0.15	0.3
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	kPa {kg/cm2}	—	—
	Fan speed	At rated engine speed	rpm	Hydraulically driven on machine side	
	Fan and alternator belt tension	Deflects when pushed with a finger force of 98 N {10 kg}	mm	Auto-tensioner	Auto-tensioner

Engine				SAA4D107E-1	
Applicable machine				PC200-10M0	
Category	Item	Measurement conditions	Unit	Standard value for new machine	Repair limit
Performance	Engine speed	Max. speed with no load	rpm	2,060 ± 50	2,060 ± 50
		Min. speed with no load	rpm	1,050 ± 25	1,050 ± 25
	Necessary starting speed	At 0°C	rpm	—	—
		At –20°C	rpm	—	—
Air intake and exhaust system	Intake resistance	At rated horsepower	kPa {mmH2O}	Max. 3.73 {Max. 380}	7.45 {760}
	Intake pressure (Aftercooler inlet)	At rated horsepower	kPa {mmHg}	Min. 133 {Min. 1,000}	107 {800}
	Exhaust pressure (Turbine inlet press.)	At rated horsepower	kPa {mmHg}	—	—
	Exhaust temperature (Turbine outlet temp.)	At all speed (at 20°C)	°C	Max. 560	610
	Exhaust gas color	At rated horsepower	Opacity %	Max. 12	22
		Quick acceleration (Low idle → high idle)	Opacity %	Max. 25	35
	Valve clearance	Intake valve	mm	0.25	0.152 to 0.381
		Exhaust valve	mm	0.51	0.381 to 0.762
Body	Compression pressure	Oil temperature: 40 to 60°C Engine speed: 250 to 280 rpm	MPa {kg/cm2}	Min. 2.41 {Min. 24.6}	1.69 {17.2}
	Blowby pressure	At rated horsepower	kPa {mmH2O}	Max. 0.98 {Max. 100}	1.96 {200}
Lubrication system	Oil pressure	At rated horsepower (Oil temperature: Min. 80°C) SAE15W-40	MPa {kg/cm2}	Min. 0.29 {Min. 3.0}	0.25 {2.5}
		At low idle (Oil temperature: Min. 80°C) SAE15W-40	MPa {kg/cm2}	Min. 0.10 {Min. 1.0}	0.07 {0.7}
	Oil temperature	At all speed (Oil in oil pan)	°C	80 to 110	120
	Oil consumption ratio	At continuous rated horsepower (Ratio to fuel consumption)	%	Max. 0.15	0.3
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	kPa {kg/cm2}	—	—
	Fan speed	At rated engine speed	rpm	1,920	1,920
	Fan and alternator belt tension	Deflects when pushed with a finger force of 98 N {10 kg}	mm	Auto-tensioner	Auto-tensioner

Running-in standard

Engine		SAA6D107E-1				
Applicable machine		PC228US-3E0, PC228USLC-3E0				
Item		Procedure				
		1	2	3	4	5
Running time	min	2	10	2	3	3
Engine speed	rpm	1,050	1,000	1,200	1,600	2,000
Dynamometer load	N {kg}	0 {0}	98 {10}	245 {25}	440 {45}	771 {78.6}
Output	kW {HP}	0 {0}	7.4 {10}	22 {29.5}	53 {71}	116 {155}

★ The table gives the standard values for machines without fan.
★ The loads for the dynamometer are at an arm's length of 716 mm.

Performance test criteria

Engine		SAA6D107E-1			
Applicable machine		PC228US-3E0, PC228USLC-3E0			
Test item		Rated horsepower	Max. torque	Max. speed with no load	Min. speed with no load
Specification value (Gross)	—	116 ± 5.81 kW/ 2,000 rpm {155 ± 8 HP/ 2,000 rpm}	$624^{+19.6}_{-39.2}$ Nm/ 1,500 ± 100 rpm {63.6^{+2}_{-4} kgm/ 1,500 ± 100 rpm}	2,060 ± 50 rpm	1,050 ± 25 rpm
Engine speed	rpm	2,000	1,500 ± 100	2,060 ± 50	1,050 ± 25
Dynamometer load	N {kg}	771 {78.6}	871 {88.8}	—	—
Output (Gross)	kW {HP}	116 {155}	—	—	—
Torque (Gross)	Nm {kgm}	—	624 {63.6}	—	—
Fuel consumption	sec/ 300cc	35	—	—	—
Coolant temperature	°C	75 to 94	75 to 94	75 to 94	75 to 94
Lubricating oil temperature	°C	80 to110	80 to 110	80 to 110	80 to 110
Lubricating oil pressure	kPa {kg/cm^2}	Min. 261.8 {Min. 2.67}	Min. 193.2 {Min. 1.97}	Min. 261.8 {Min. 2.67}	Min. 54.9 {Min. 0.56}
Exhaust temperature	°C	Max. 650	Max. 650	—	—

★ This table shows the standard values using the JIS correction factor.
★ The output and torque values in the table are the standard values with the fan removed, so they are different from the specification values.
★ This table shows the standard values when an air cleaner and a muffler are installed, and no load is applied to the alternator.
★ The dynamometer load shows the value for an arm length of 716 mm.
★ Use ASTM D975 diesel oil as the fuel.
★ Use SAE15W-40 as the lubricating oil.

Running-in standard

Engine		SAA6D107E-1				
Applicable machine		A6D107E-GD-1 (Portable generator)				
Item		Procedure				
		1	2	3	4	5
Running time	min	2	10	2	3	3
Engine speed	rpm	650	1,000	1,200	1,500	1,800
Dynamometer load	N {kg}	0 {0}	98 {10}	245 {25}	440 {45}	1,030 {105}
Output	kW {HP}	0 {0}	7.4 {10}	22 {29.5}	50 {68}	139 {189}

★ The table gives the standard values for machines without fan.
★ The loads for the dynamometer are at an arm's length of 716 mm.

Performance test criteria

Engine		SAA6D107E-1			
Applicable machine		A6D107E-GD-1 (Portable generator)			
Test item		50 Hz Rated horsepower	60 Hz Rated horsepower	Max. speed with no load	Min. speed with no load
Specification value (Gross)	—	115 ± 5.81 kW/1,500 rpm {155 ± 7.8 HP/1,500 rpm}	139 ± 6.99 kW/1,800 rpm {186 ± 9.4 HP/1,800 rpm}	Max.1,890 rpm	650 ± 25 rpm
Engine speed	rpm	1,500	1,800	Max. 1,890	650 ± 25
Dynamometer load	N {kg}	1,027 {104.7}	1,030 {105}	—	—
Output (Gross)	kW {HP}	115 {155}	139 {186}	—	—
Torque (Gross)	Nm {kgm}	—	—	—	—
Fuel consumption	sec/ 300cc	35	29	—	—
Coolant temperature	°C	75 to 94	75 to 94	75 to 94	75 to 94
Lubricating oil temperature	°C	80 to 110	80 to 110	80 to 110	80 to 110
Lubricating oil pressure	kPa {kg/cm^2}	Min. 193.2 {Min. 1.97}	Min. 261.8 {Min. 2.67}	Min. 261.8 {Min. 2.67}	Min. 98 {Min. 1.0}
Exhaust temperature	°C	Max. 650	Max. 650	—	—

★ This table shows the standard values using the JIS correction factor.
★ The output and torque values in the table are the standard values with the fan removed, so they are different from the specification values.
★ This table shows the standard values when an air cleaner and a muffler are installed, and no load is applied to the alternator.
★ The dynamometer load shows the value for an arm length of 716 mm.
★ Use ASTM D975 diesel oil as the fuel.
★ Use SAE15W-40 as the lubricating oil.

Testing and adjusting tools list

Testing and adjusting item	Symbol		Part No.	Part name	Q'ty	Remarks
Testing boost pressure	A		799-201-2202	Boost gauge kit	1	–101 – 200 kPa {–760 – 1,500 mmHg}
			799-401-2220	Hose	1	I-coupler type (if necessary)
Adjusting valve clearance	C	1	795-799-1131	Gear	1	
		2	Commercially available	Clearance gauge	1	
Testing compression pressure	D	1	795-799-6700	Puller	1	
		2	795-502-1590	Gauge assembly	1	
		3	795-790-4410	Adapter	1	
		4	6754-11-3130	Gasket	1	
Testing blowby pressure	E	1	799-201-1504	Blowby checker	1	0 – 5 kPa {0 – 500 mmH_2O}
		2	795-790-3300	Blowby tool	1	
Testing oil pressure	F	1	799-101-5002	Hydraulic tester	1	Pressure gauge: 2.5, 6, 40, 60 MPa {25, 60, 400, 600 kg/cm^2}
		2	790-301-1230	Nipple	1	
		3	799-101-5160	Nipple	1	
		4	799-401-2320	Gauge	1	Pressure gauge: 1.0 MPa {10 kg/cm^2}
Testing fuel pressure	G	1	799-101-5002	Hydraulic tester	1	Pressure gauge: 2.5, 6, 40, 60 MPa {25, 60, 400, 600 kg/cm^2}
			790-261-1204	Digital hydraulic tester	1	Pressure gauge: 60 MPa {600 kg/cm^2}
		2	6732-81-3170	Adapter	1	10 × 1.0 mm → Rc1/8
			795-790-4430	Adapter	1	10 × 1.0 mm → Rc1/8
			6215-81-9710	O-ring	1	
		3	799-401-2320	Gauge	1	Pressure gauge: 1.0 MPa {10 kg/cm^2}
		4	795-790-5110	Screw	1	
		5	799-201-2202	Boost gauge kit	1	
Testing fuel pressure (*)	G	1	799-101-5002	Hydraulic tester	1	Pressure gauge: 2.5, 6, 40, 60 MPa {25, 60, 400, 600 kg/cm^2}
			790-261-1204	Digital hydraulic tester	1	Pressure gauge: 60 MPa {600 kg/cm^2}
		2	795-790-4430	Adapter	1	10 × 1.0 mm → Rc1/8
			6215-81-9710	O-ring	1	
		5	799-201-2202	Boost gauge kit	1	
		6	795-790-5110	Screw	1	
		7	799-401-2320	Gauge	1	Pressure gauge: 1.0 MPa {10 kg/cm^2}
Testing fuel delivery, return and leak amount	H	1	795-790-4700	Tester kit	1	
		3	6754-71-5340	Connector	1	
			6754-71-5350	Washer	1	
		4	Commercially available	Measuring cylinder	1	
		5	Commercially available	Stopwatch	1	
		6	Commercially available	Hose	1	Inside diameter: ø14 mm
		7	Commercially available	Hose	1	Inside diameter: ø8 mm

*: Devices shown with this mark are for testing and adjustment for HB205-1M0 and HB215LC-1M0 .

Testing blowby pressure

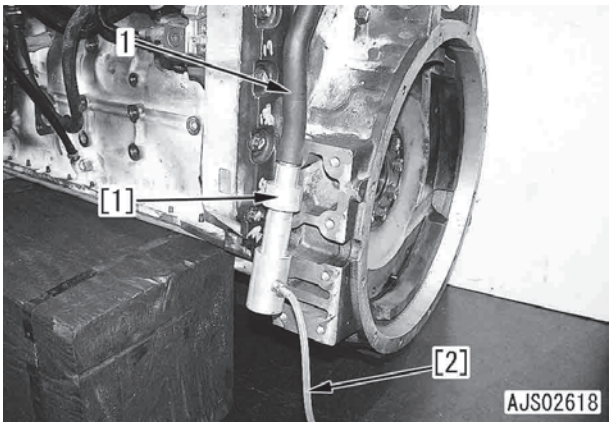
★ Testing tool for blowby pressure

Symbol		Part No.	Part name
E	1	799-201-1504	Blowby checker
	2	795-790-3300	Blowby tool

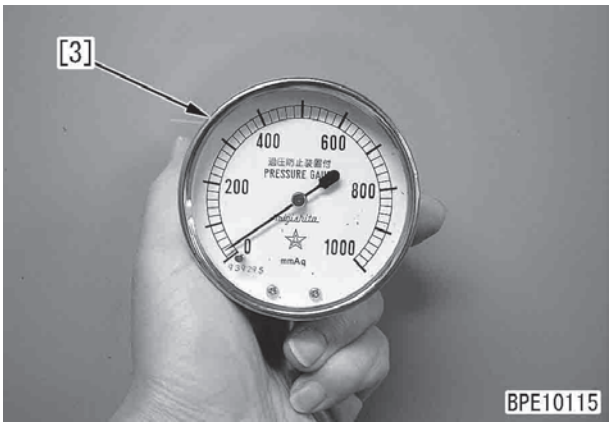
★ The test point is subject to machine models.
★ The photo below shows 6D107E-1 as an example.

1. Install adaptor [1] of blowby checker **E1** to the tip of blowby hose (1).

2. Connect hose [2], and then connect it to adaptor [1] and gauge [3].



3. Run the engine at the rated output and test the blowby pressure.
   ★ When testing with the engine mounted on the machine, test on the condition described in the shop manual for the machine.



4. After finishing testing, remove the measuring tools and return the removed parts.

Testing fuel delivery, return and leak amount

★ Testing tools for fuel delivery, return and leak amount.

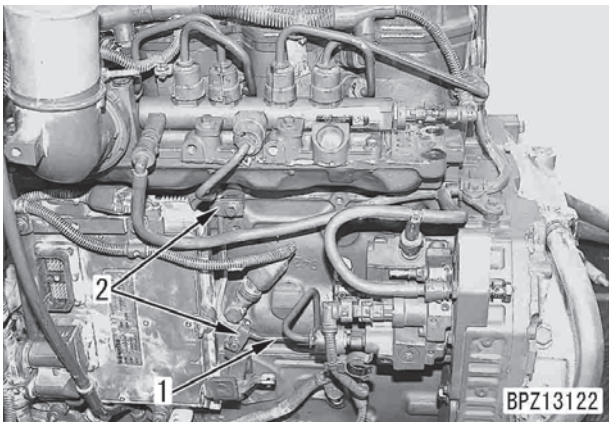
Symbol		Part No.	Part name
H	1	795-790-4700	Tester kit
	3	6754-71-5340	Connector
		6754-71-5350	Washer
	4	Commercially available	Measuring cylinder
	5	Commercially available	Stopwatch
	6	Commercially available	Hose (Inside diameter: 14 mm)
	7	Commercially available	Hose (Inside diameter: 8 mm)

★ **See PAGE 30 for procedure of "Testing fuel discharge, return and leakage" of HB205-1M0 and HB215LC-1M0.**

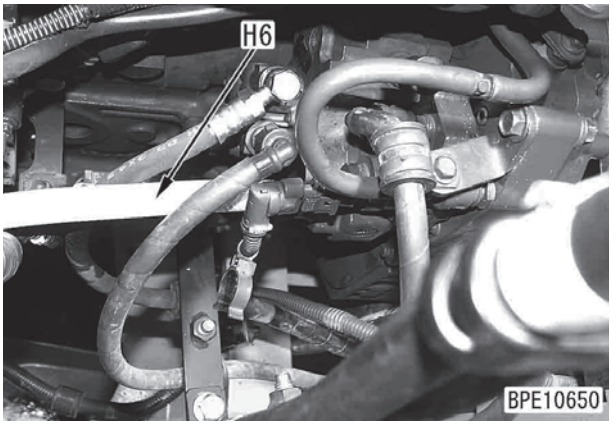
★ Prepare a container of 20 ℓ for fuel leakage during testing.

1. Measuring supply pump delivery (4D107E-1)

1) Loosen clamp (2) of discharge tube (1) of the supply pump and disconnect tube (1).

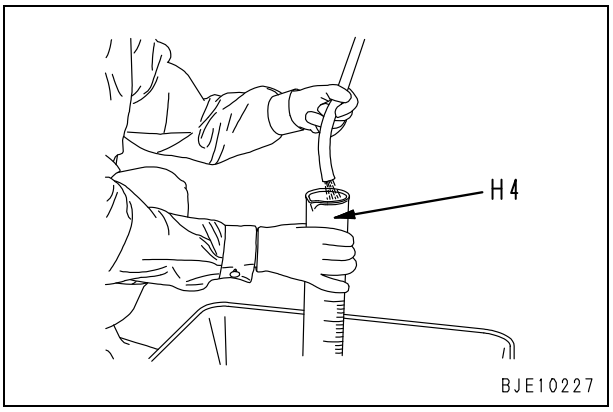


2) Install test hose **H6** to the nipple on the discharge side of the supply pump.
   ★ Fix the hose with a wire etc.
   ★ Adjust the route of the test hose so that it will not slacken and put its end in an oil container.



3) Crank the engine for 30 seconds and measure the delivery with measuring cylinder **H4**.
   ★ Adjust the route of the test hose so that it will not slacken and put its end in an oil container.
   ★ Do not crank the engine for more than 30 seconds to protect the starting motor in any case other than this measurement.
   ★ If the supply pump delivery is in the following standard range, it is normal.

At cranking speed (125 rpm)	Min. 75 cc
At cranking speed (150 rpm)	Min. 90 cc



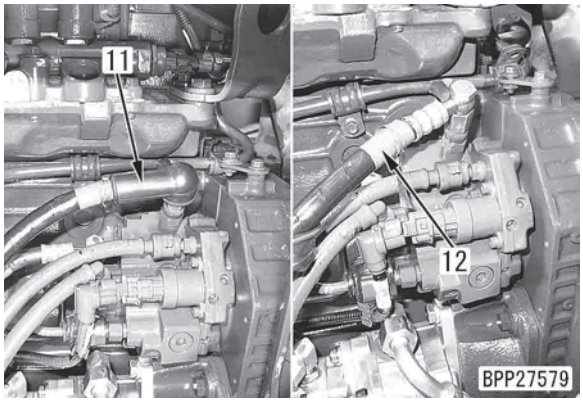
4) After finishing measurement, remove the measuring instruments and return the removed parts.
   Tube sleeve nut:
   35 ± 4 Nm {3.6 ± 0.4 kgm}
   Clamp mounting bolt:
   24 ± 4 Nm {2.5 ± 0.4 kgm}

4. Testing supply pump return rate

★ Subtract the pressure limiter leakage and injector return rate from overall return rate to measure the supply pump return rate. Therefore, check that the leakage from the pressure limiter and return rate from the injector are normal, and then perform the measurement.

★ Since fuel may flow back when disconnecting fuel return hose (12), drain the fuel from the fuel tank to the lower level than the supply pump installation position.

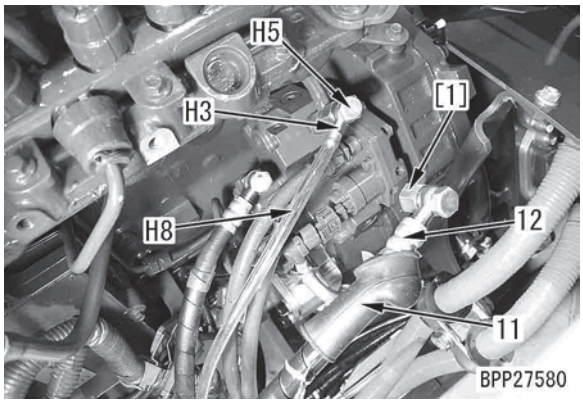
1) Move rubber cover (11), and disconnect fuel return hose (12).



2) Install cap nut [1] of tester kit **H1** to fuel return hose (12) side to prevent the fuel from flowing out.
   ★ When installing cap nut [1], be sure to install seal washer **H4**.

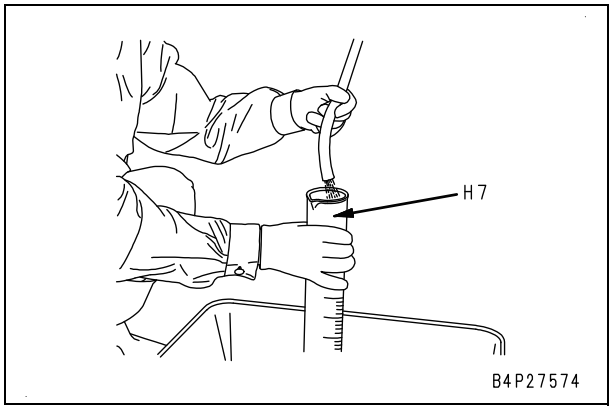
3) Install joint **H3** to the supply pump side with joint bolt **H5**.
   ★ When installing joint **H3** and joint bolt **H5**, be sure to install seal washer **H4**.
   Joint bolt H5:
   19.6 to 29.4 Nm {2.0 to 3.0 kgm}

4) Install joint **H3** to hose **H8**.



5) Start the engine and run it at low idle, and measure the return rate in 25 seconds by using measuring cylinder **H7**.
   ★ Supply pump return rate = (Overall return rate) - (pressure limiter leakage) - (injector return rate)
   ★ When the return rate from the supply pump is in the following range, it is normal.

At low idle (750 rpm)	Max. 400 cc



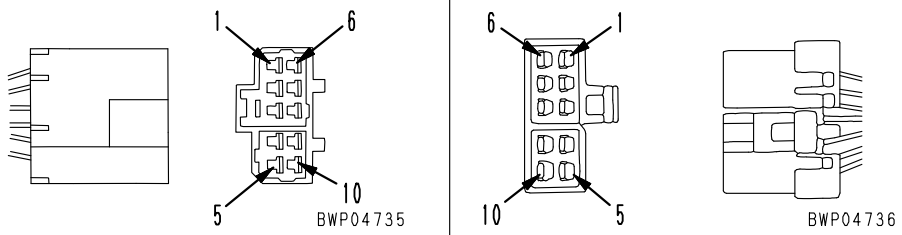
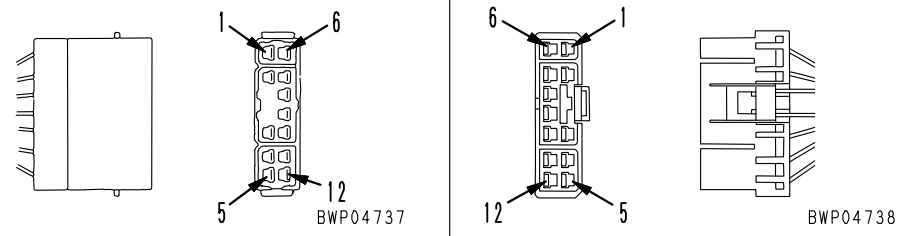
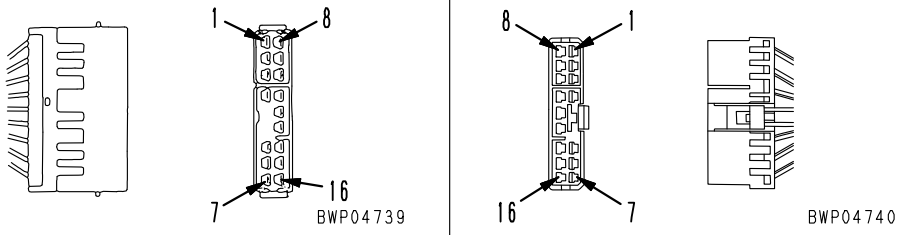
6) After finishing the test, remove the testing tools and restore the machine.

Error code of INSITE	Failure code of applicable machine	Trouble	Reference document No.
689	CA689	Abnormality in engine Ne speed sensor	Troubleshooting of electrical system (E-mode), Part 2 SEN00255
731	CA731	Abnormality in engine Bkup speed sensor phase	
757	CA757	Loss of all data in engine controller	
778	CA778	Abnormality in engine Bkup speed sensor	
1633	CA1633	Abnormality in KOMNET	
2185	CA2185	Throttle sensor power supply high error	
2186	CA2186	Throttle sensor power supply low error	
2249	CA2249	No-pressure feed 2 by supply pump	
2311	CA2311	Abnormality in IMV solenoid	
2555	CA2555	Disconnection in intake air heater relay	
2556	CA2556	Short circuit in intake air heater relay	
—	B@BAZG	Derating of speed by engine oil pressure reduction	
—	B@BAZK	Engine oil level low	
—	B@BCNS	Engine overheat	

★ Error code of INSITE:
3- or 4-digit error code displayed on INSITE when a failure occurrence condition is confirmed using INSITE of Cummins. inc.
★ Failure code of applicable machine:
5- or 6-digit failure code displayed on the machine monitor when a failure occurrence condition is confirmed using the machine monitor at the applicable machine side.

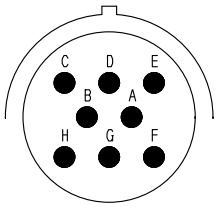
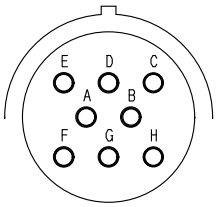
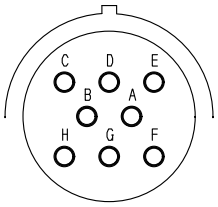
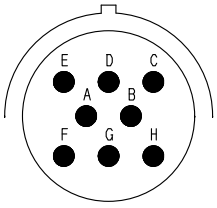
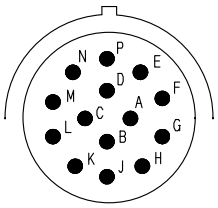
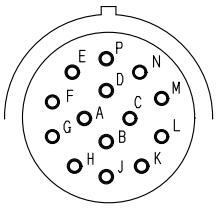
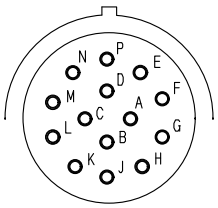
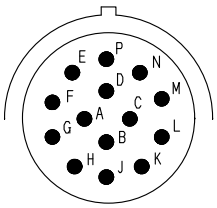
- **Genrator controller only**

Machine failure code	Failure phenomenon	Reference document No.
A8	Rated Speed Adjustment Volume (Isochronous) High Error	Troubleshooting of electrical system (E-mode), Part 2 SEN00255
A9	Rated Speed Adjustment Volume (Isochronous) Low Error	
AA	Rated Speed Adjustment Volume (Droop) High Error	
AB	Rated Speed Adjustment Volume (Droop) Low Error	
AF	Abnormality in KOMNET (CR710 error recognition)	
b6	Droop Rate Adjustment Volume High Error	
b7	Droop Rate Adjustment Volume Low Error	
b8	Low Idle Speed Adjustment Volume High Error	
b9	Low Idle Speed Adjustment Volume Low Error	
bc	Rated Speed Median Adjustment Volume High Error	
bd	Rated Speed Median Adjustment Volume Low Error	
bE	Ramp Time Adjustment Volume High Error	
bF	Ramp Time Adjustment Volume Low Error	

No. of pins	S type connector		
	Male (female housing)	Female (male housing)	Testing connection use special tool Part No.
10 (Blue)			—
	—	—	
12 (Blue)			799-601-7160 (T-adapter)
	Part No. : 08056-11272	Part No. : 08056-11282	
16 (Blue)			799-601-7170 (T-adapter)
	Part No. : 08056-11672	Part No. : 08056-11682	

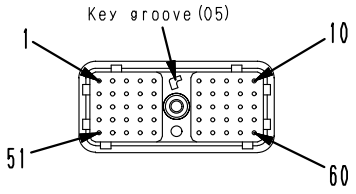
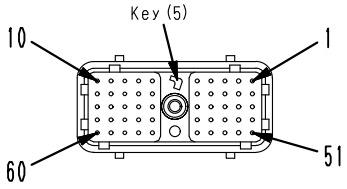
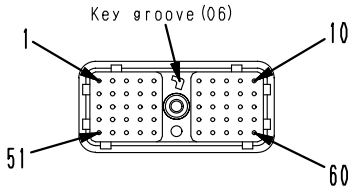
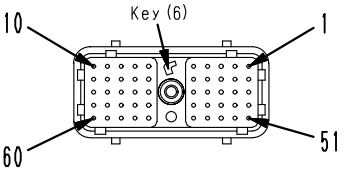
B4D18195

[The pin No. is also marked on the connector (electric wire insertion end)]

Type (shell size code)	HD30 Series connector		
	Body (plug)	Body (receptacle)	Testing connection use special tool Part No.
18-8 (1)	Pin (male terminal)	Socket (female terminal)	799-601-9210 (T-adapter)
	 BWP05001	 BWP05002	
	Part No. :08191-11201, 08191-11202, 08191-11205, 08191-11206	Part No. :08191-14101, 08191-14102, 08191-14105, 08191-14106	
	Socket (female terminal)	Pin (male termial)	799-601-9210 (T-adapter)
	 BWP05003	 BWP05004	
	Part No. :08191-12201, 08191-12202, 08191-12205, 08191-12206	Part No. :08191-13101, 08191-13102, 08191-13105, 08191-13106	
18-14 (2)	Pin (male terminal)	Socket (female terminal)	799-601-9220 (T-adapter)
	 BWP05005	 BWP05006	
	Part No. :08191-21201, 08191-12202, 08191-21205, 08191-12206	Part No. :08191-24101, 08191-24102, 08191-24105, 08191-24106	
	Socket (female terminal)	Pin (male termial)	799-601-9220 (T-adapter)
	 BWP05007	 BWP05008	
	Part No. :08191-22201, 08191-22202, 08191-22205, 08191-22206	Part No. :08191-23101, 08191-23102, 08191-23105, 08191-23106	

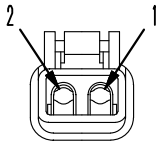
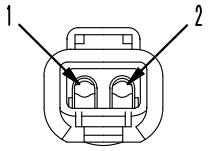
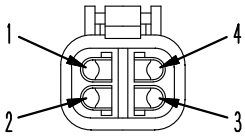
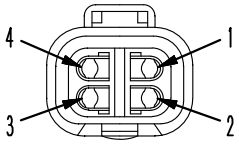
B4D18405

[The pin No. is also marked on the connector (electric wire insertion end)]

No. of pins	DRC26 Series connector		Testing connection use special tool Part No.
	Male pin (female housing)	Female pin (male housing)	
60 -05※	 BJD14063	 BJD14064	799-601-4220 (T-adapter) (Kit:799-601-4101)
	–	Part No. 08194-04104	
	※-05:Key position		
60 -06※			799-601-4390 (Socket)
	–	–	
	※-06:Key position		

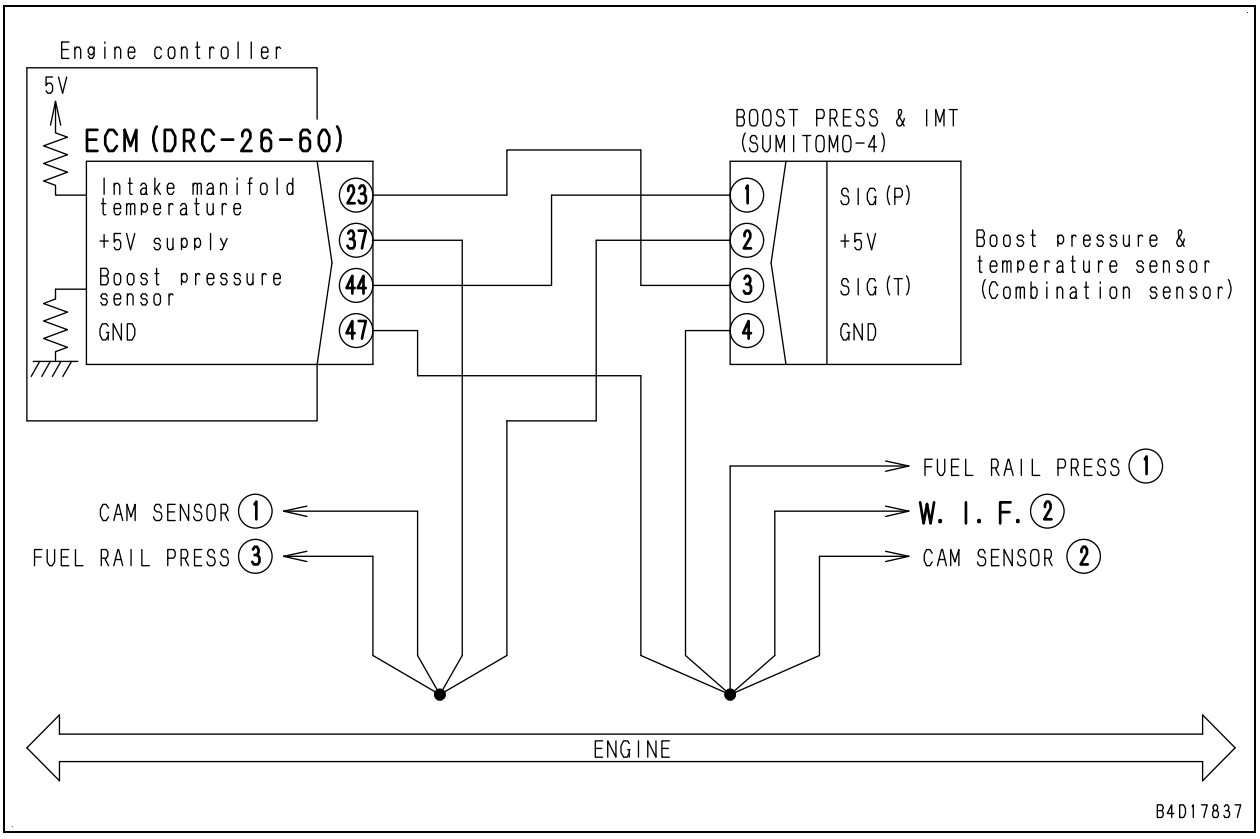
B4D18415

DT series connector for engine

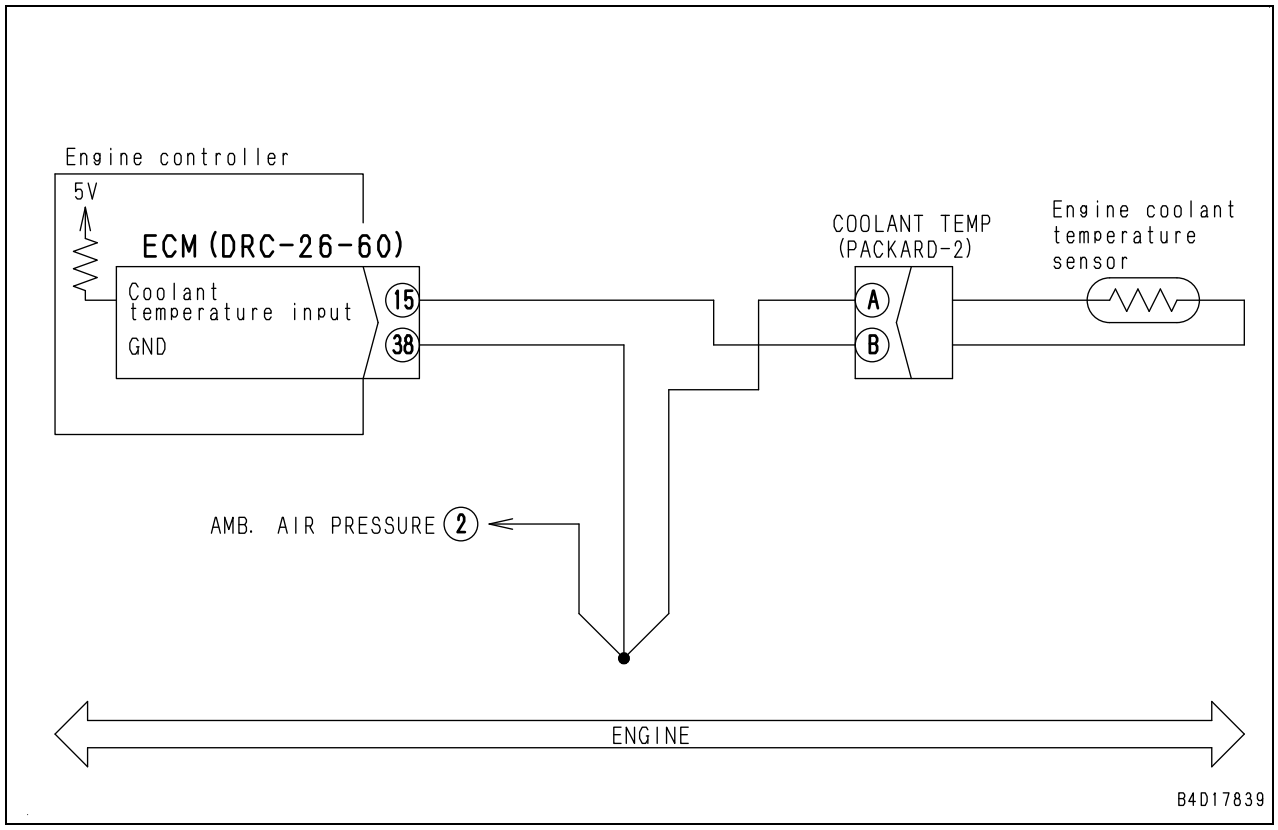
No. of pins	WIF (water in fuel) sensor (107, 114 engine)		
	Body (plug)	Body (receptacle)	Testing connection use special tool Part No.
2	 BWP05037	 BWP05038	799-601-9020 (T-adapter) (kit:799-601-4101) (kit:799-601-4201)
	Part No. :08192-12200 (normal type) 08192-22200 (fine wire type)	Part No. :08192-12100 (normal type) 08192-22100 (fine wire type)	
No. of pins	EGR (by pass) valve stroke sensor (125, 140, 170 engine)		
	Body (plug)	Body (receptacle)	
4	 BWP05041	 BWP05042	799-601-9040 (T-adapter) (kit:799-601-4101) (kit:799-601-4201)
	Part No. :08192-14200 (normal type) 08192-24200 (fine wire type)	Part No. :08192-14100 (normal type) 08192-24100 (fine wire type)	

B4D18425

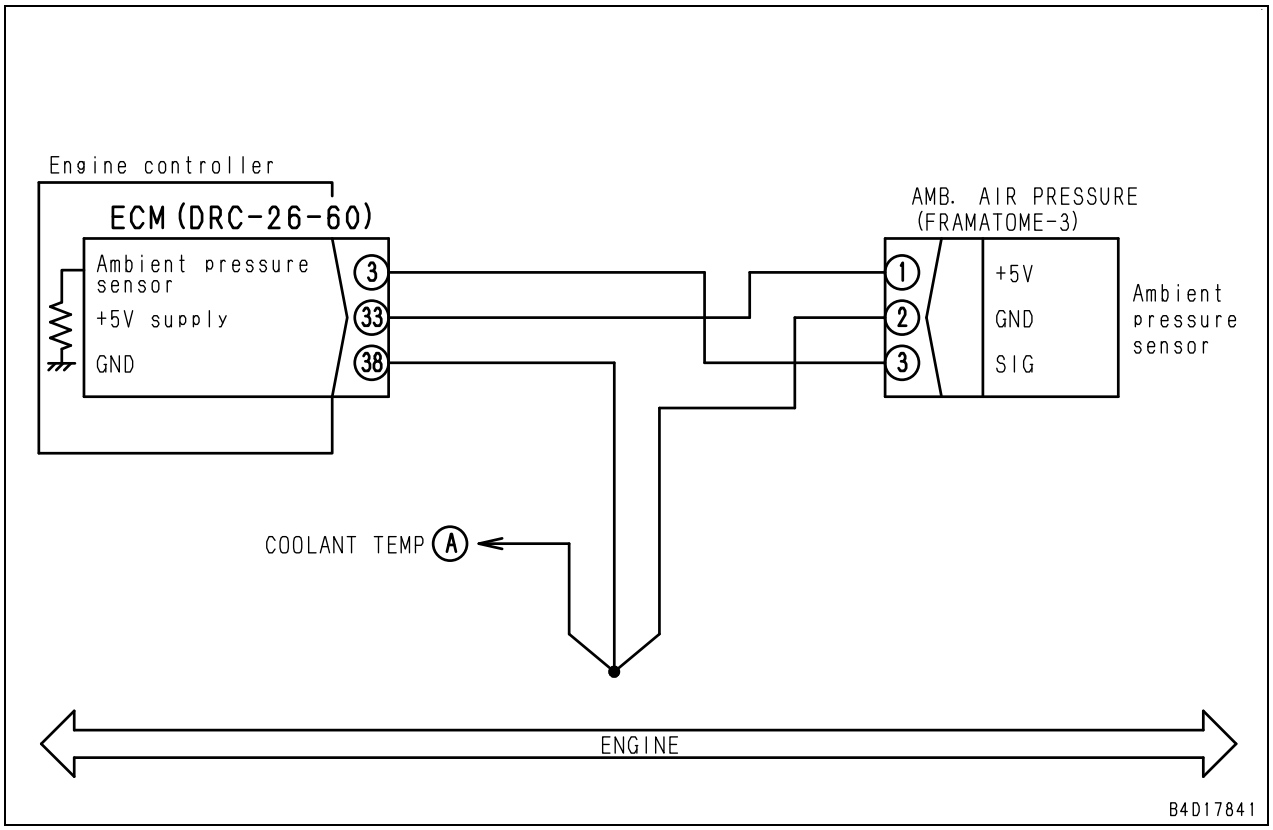
Circuit diagram related to boost pressure, temperature sensor (combination sensor)



Circuit diagram related to coolant temperature sensor

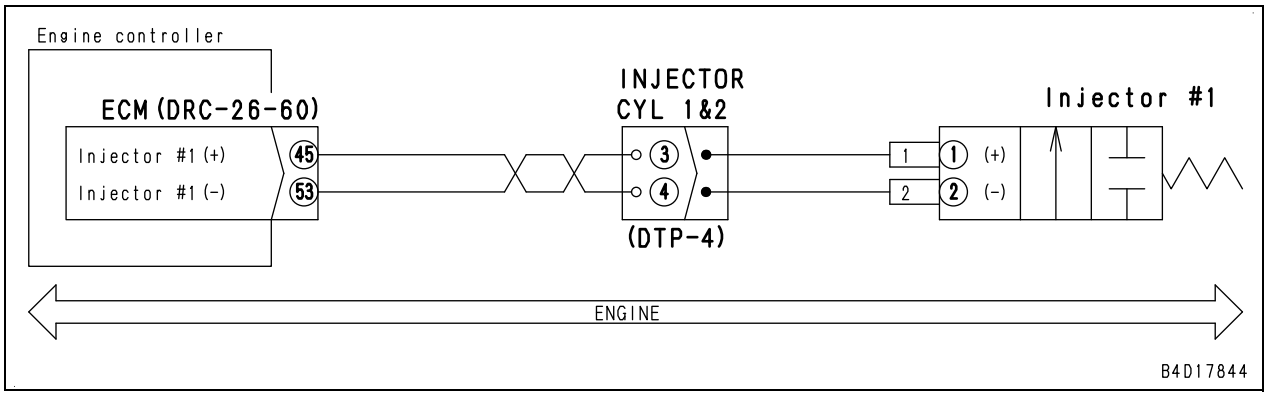


Circuit diagram related to atmospheric pressure sensor



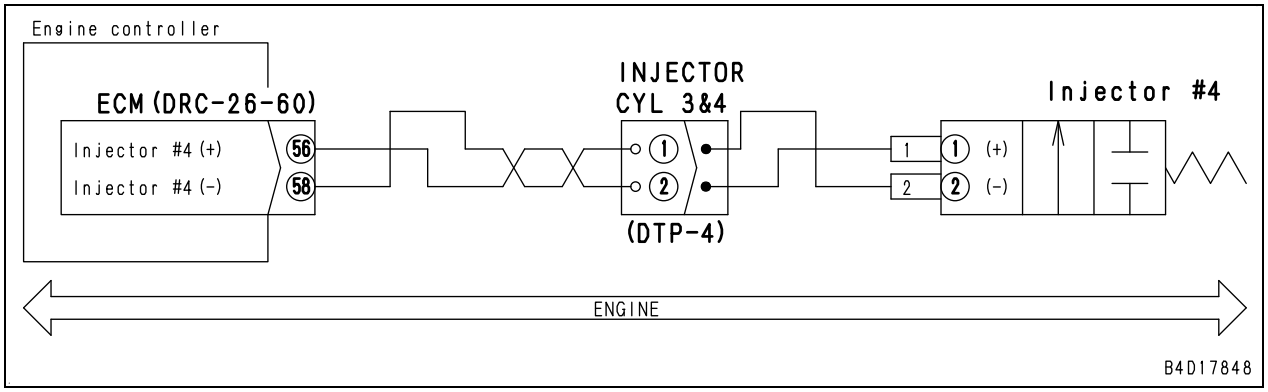
	Causes		Standard value in normal state/Remarks on troubleshooting	
Possible causes and standard value in normal state	6	Short circuit in wiring harness	1. Turn starting switch to OFF position. 2. Disconnect connectors ECM and INJECTOR CYL 1&2 and connect T-adapter to female side of ECM. ★ Check by using multimeter in continuity mode.	
			Between ECM (female) (45) and each pin other than (45)	No continuity (no sound is heard.)
			Between ECM (female) (53) and each pin other than (53)	No continuity (no sound is heard.)
	7	Defective other cylinder injectors or wiring harness	If failure codes for other injectors are displayed, perform troubleshooting for them, too.	
	8	Defective engine controller	If no failure is found by checks on causes 1 to 7, engine controller is defective. (Since this is internal failure, troubleshooting cannot be performed.)	

Circuit diagram related to injector No. 1

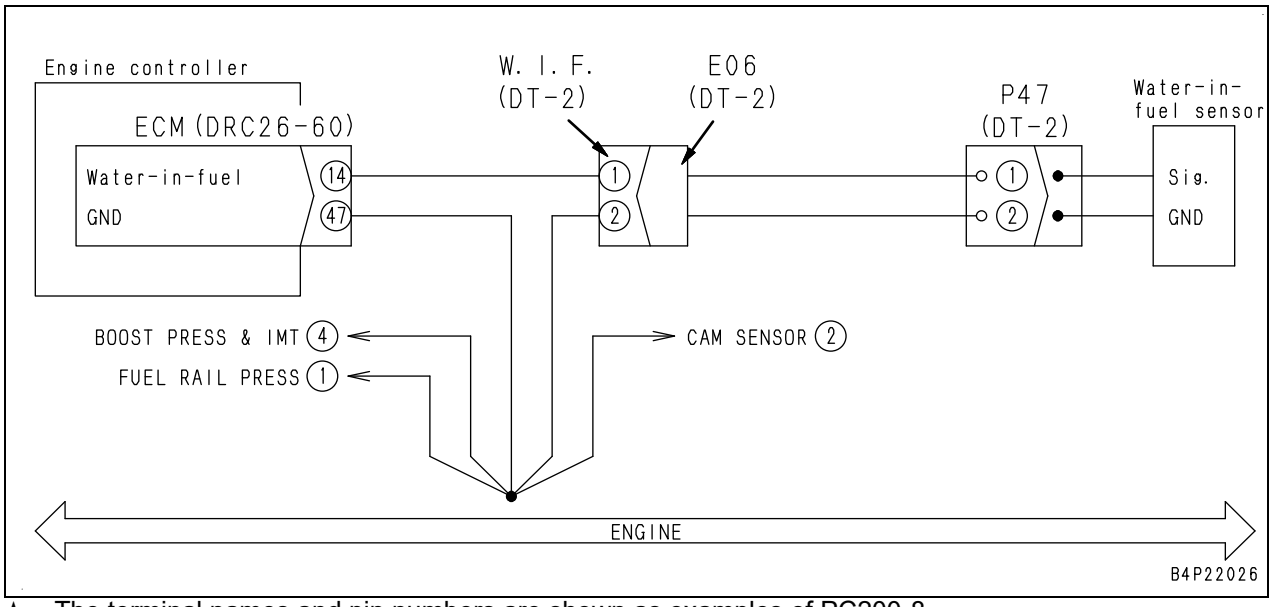


	Causes		Standard value in normal state/Remarks on troubleshooting	
Possible causes and standard value in normal state	6	Short circuit in wiring harness	1. Turn starting switch to OFF position. 2. Disconnect connectors ECM and INJECTOR CYL 3&4 and connect T-adapter to female side of ECM. ★ Check by using multimeter in continuity mode.	
			Between ECM (female) (56) and each pin other than (56)	No continuity (no sound is heard.)
			Between ECM (female) (58) and each pin other than (58)	No continuity (no sound is heard.)
	7	Defective other cylinder injectors or wiring harness	If failure codes for other injectors are displayed, perform troubleshooting for them, too.	
	8	Defective engine controller	If no failure is found by above checks, engine controller is defective. (Since this is internal failure, troubleshooting cannot be performed.)	

Circuit diagram related to injector No. 4

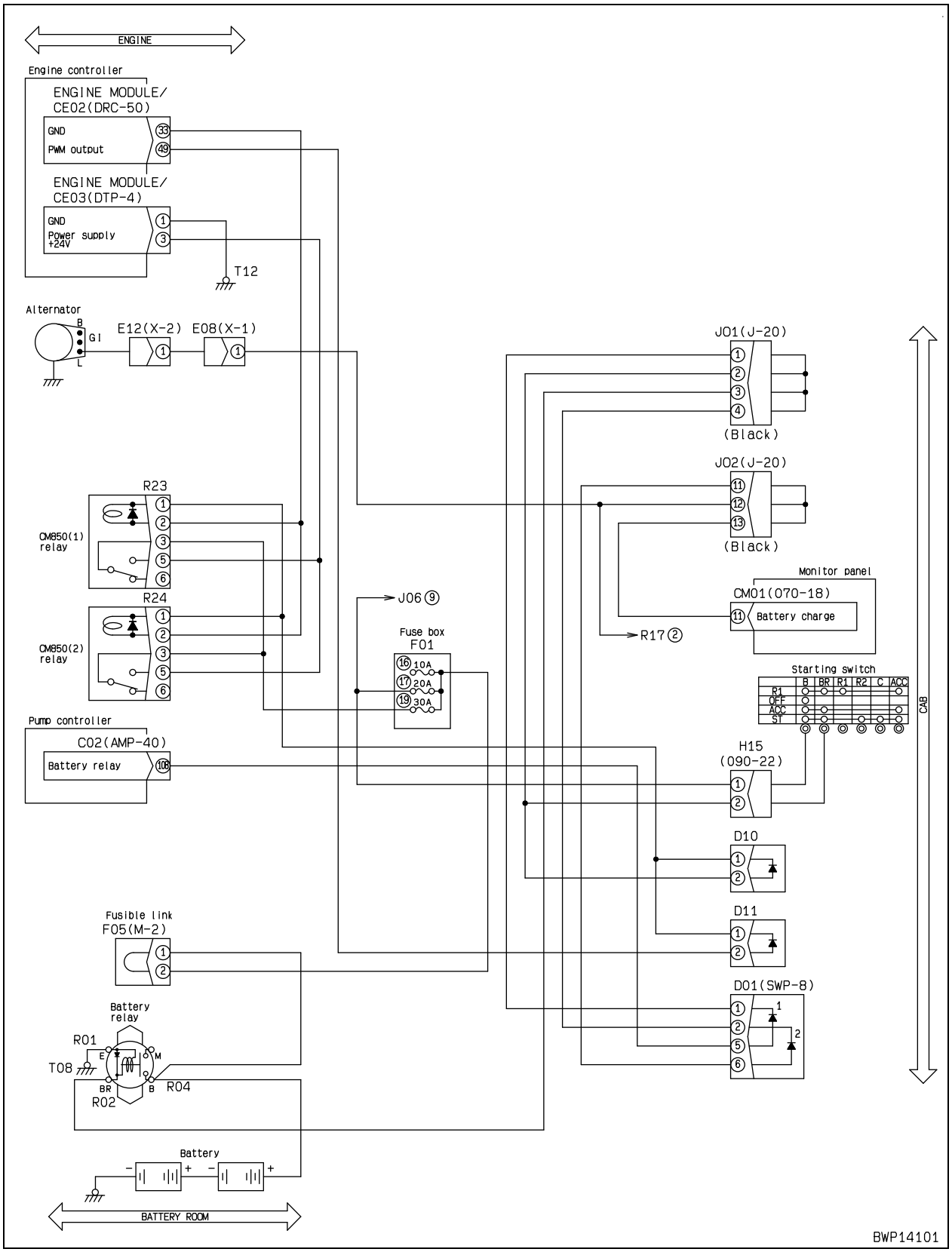


Circuit diagram related to water-in-fuel sensor



★ The terminal names and pin numbers are shown as examples of PC200-8.

Circuit diagram related to engine controller power supply (PC200-8, as an example)



E-43 Code [689/CA689] Abnormality in engine Ne speed sensor

Error code	Failure code	Trouble	Abnormality in engine Ne speed sensor
689	**CA689**		
Contents of trouble	• Abnormality occurred in signals from engine Ne speed sensor.		
Action of controller	• Controls Ne speed sensor with signals of Bkup speed sensor.		
Problem that appears on machine	• There is hunting from engine. • Starting performance is poor. • Engine output drops.		
Related information	• Method of reproducing failure code: Start engine. • Since inside of speed sensor is not composed of coil but Hall sensor and electronic circuit, speed sensor cannot be determined to be normal by measuring its resistance with multimeter. • Since speed sensor output is 5 V pulse voltage during normal operation, it cannot be measured with multimeter. • Speed sensor senses passing slotted hole in speed sensing wheel that is installed on inside of crankshaft vibration damper and rotated by crankshaft.		

	Causes		Standard value in normal state/Remarks on troubleshooting			
Possible causes and standard value in normal state	1	Defective wiring harness connector	Connecting parts among engine Ne speed sensor, engine wiring harness, and engine controller are suspected. Inspect them directly. • Loose connector, broken lock, broken seal • Corrosive, bent, broken, forced-in, or extended pin • Humidity in connector, entry of dirt or dust, poor insulation			
	2	Defective Ne speed sensor power supply line	If failure code **[CA238]** is also displayed, perform troubleshooting for it first.			
	3	Breakage or improper installation (looseness) of engine Ne speed sensor	Engine Ne speed sensor may be broken or may have improper installation (looseness). Check it directly.			
	4	Defective Ne speed sensor power supply input	1. Turn starting switch to OFF position. 2. Disconnect connector CRANK SENSOR and connect T-adapter to female side. 3. Turn starting switch to ON position.			
			Between CRANK SENSOR (female) (1) and (2)	Power input	Voltage	4.75 - 5.25V
	5	Open circuit in wiring harness (wire breakage or defective contact of connector)	1. Turn starting switch to OFF position. 2. Disconnect connectors ECM and CRANK SENSOR.			
			★ If no failure is found by checks on cause 4, this check is not required. Between ECM (female) (16) and CRANK SENSOR (female) (1)		Resistance	Max. 10 Ω
			★ If no failure is found by checks on cause 4, this check is not required. Between ECM (female) (48) and CRANK SENSOR (female) (2)		Resistance	Max. 10 Ω
			Between ECM (female) (27) and CRANK SENSOR (female) (3)		Resistance	Max. 10 Ω
	6	Short circuit in wiring harness	1. Turn starting switch to OFF position. 2. Disconnect connectors ECM and CRANK SENSOR.			
			Between ECM (female) (16) and (27) or CRANK SENSOR (female) (1) and (3)		Resistance	Min. 100 kΩ
			Between ECM (female) (27) and (48) or CRANK SENSOR (female) (2) and (3)		Resistance	Min. 100 kΩ

E-50 Code [2249/CA2249] No-pressure feed 2 by supply pump

Error code	Failure code	Trouble	No-pressure feed 2 by supply pump
2249	**CA2249**		
Contents of trouble	• No-pressure feed (2) occurred in common rail circuit.		
Action of controller	• Limits output and continues operation.		
Problem that appears on machine	• Starting performance is poor • Exhaust smoke is black • Output drops.		
Related information	• Method of reproducing failure code: Start engine.		

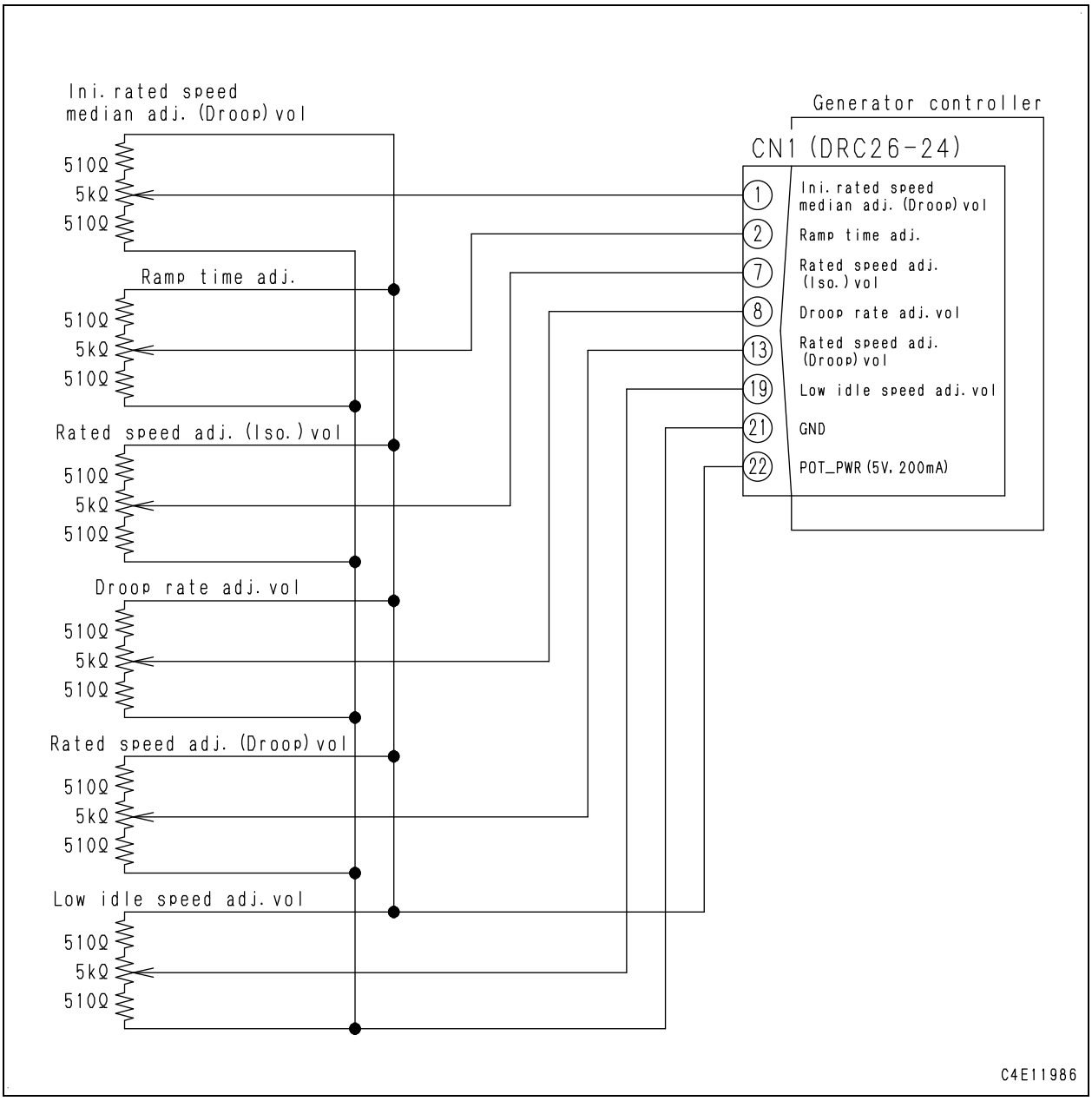
Possible causes and standard value in normal state	Causes		Standard value in normal state/Remarks on troubleshooting
	1	Perform troubleshooting for failure code [**CA559**].	

E-51 Code [2311/CA2311] Abnormality in IMV solenoid

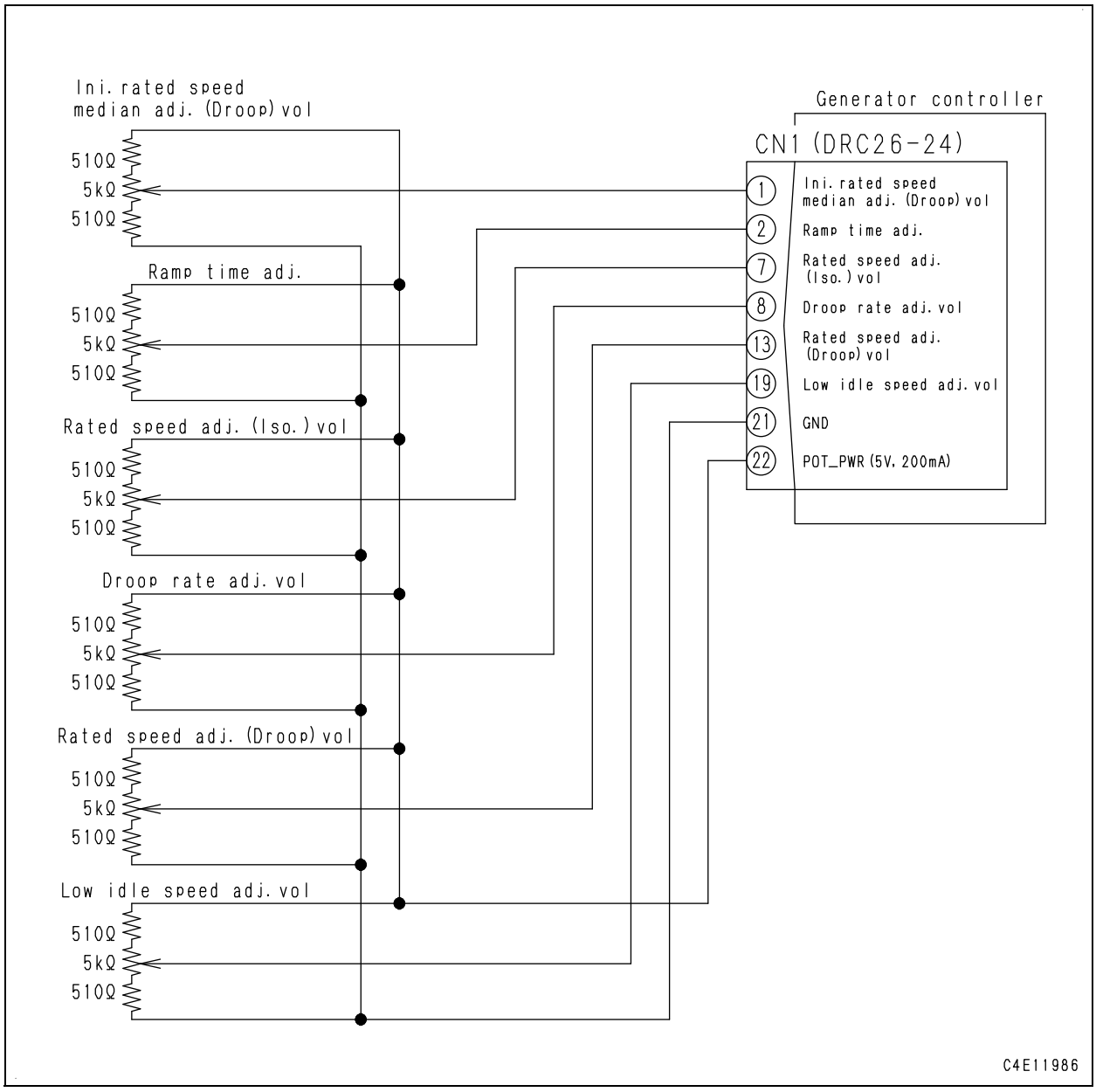
Error code	Failure code	Trouble	Abnormality in IMV solenoid
2311	**CA2311**		
Contents of trouble	• Resistance in supply pump actuator is abnormally high or low.		
Action of controller	• None in particular.		
Problem that appears on machine	• Engine output drops.		
Related information	• Method of reproducing failure code: Start engine.		

Possible causes and standard value in normal state	Causes	Standard value in normal state/Remarks on troubleshooting
	Perform troubleshooting for failure codes [**CA271**] and [**CA272**].	

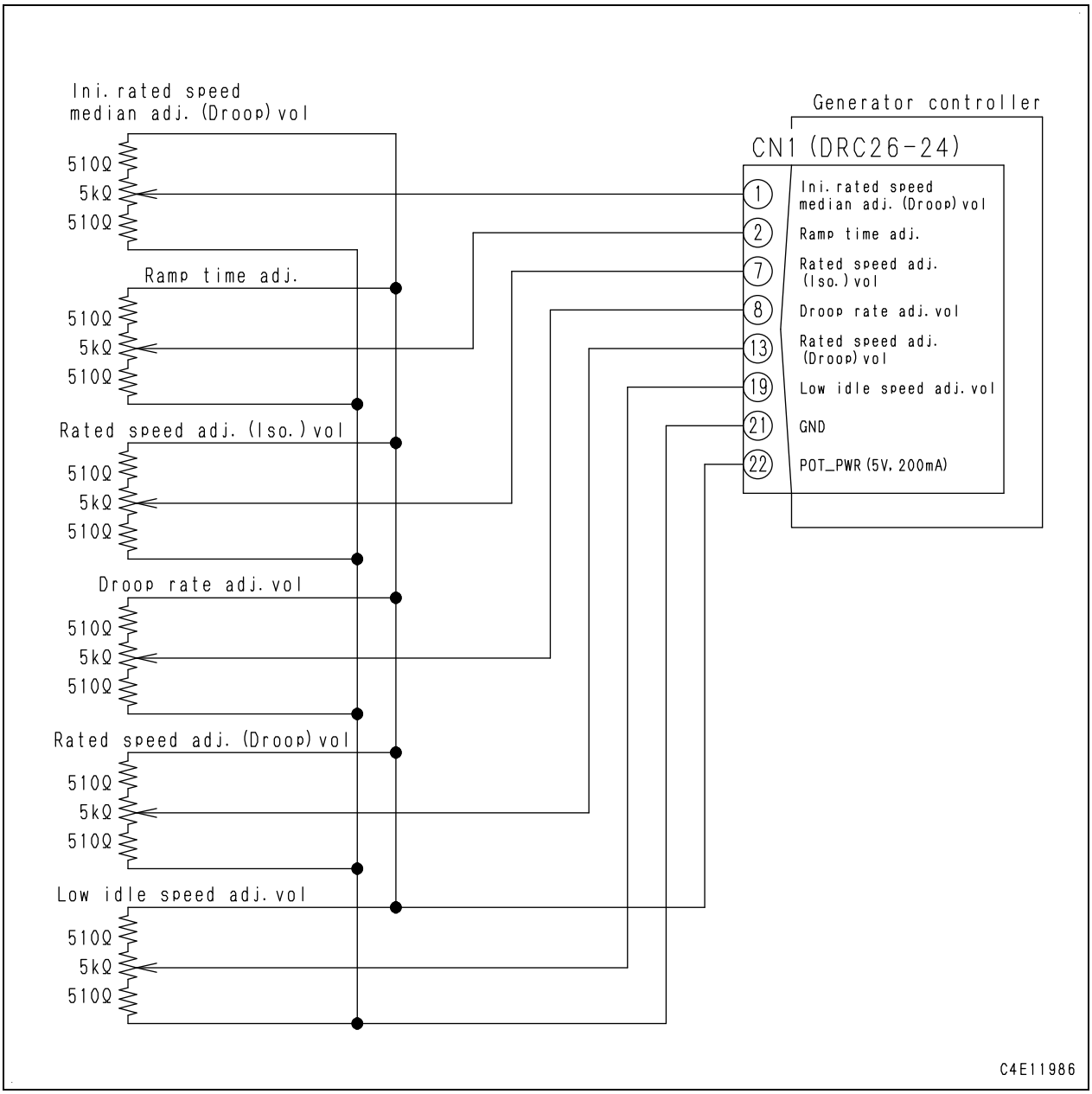
Circuit diagram related to rated speed adjustment (Isochronous) volume



Circuit diagram related to droop rate adjustment volume



Circuit diagram related to rated speed median adjustment volume



Items listed in the [Questions] and [Check items] and related to the [Causes] are marked with △, ○, or ◎.

△ : Causes to be referred to for questions and check items

○ : Causes related to questions and check items

◎ : Causes highly probable among ones marked with ○

★ When narrowing the “causes“, apply the items marked with ◎ before those marked with ○.
When narrowing the causes, do not apply the items marked with △. (If no items have other marks and the causes cannot be narrowed, however, you may apply them.)

S-6 Engine lacks output (or lacks power)

General causes why engine lacks output

- Insufficient intake of air
- Insufficient supply of fuel
- Defective condition of fuel injection
- Improper selection of fuel
- There is overheating
  → See “S-14 Coolant temperature becomes too high (Overheating)“
- Controller is controlling in derate mode (limiting injection rate (output) because of an error in electrical system)

			Causes															
			Clogged air cleaner element	Air leakage from air intake piping	Seized turbocharger, interference of turbocharger	Defective contact of valve and valve seat	Improper valve clearance	Worn piston ring, cylinder	Clogged air breather hole of fuel tank cap	Leaking, clogged fuel piping	Clogging of fuel filter	Stuck, seized supply pump plunger	Clogged injector, defective spray (dirt in injector)	Defective drive of injector (signal, solenoid)	Defective installation of boost pressure sensor (air leakage)	Defective boost pressure sensor, wiring harness	Clogged fuel spill piping
Questions	Confirm recent repair history																
	Degree of use of machine	Operated for long period	△			△		△			△						
	Power was lost	Suddenly		○	◎									○	○	○	○
		Gradually	○			○		○			○		○		○		
	Non-specified fuel is being used										○	○	○				
	Replacement of filters has not been carried out according to Operation and Maintenance Manual		◎								◎						
	Oil must be added more frequently					○		○									
Check items	Dust indicator is red (if indicator is installed)		◎	◎													
	Air breather hole of fuel tank cap is clogged				◎				◎								
	Fuel is leaking from fuel piping									◎							
	Output becomes insufficient after short stop of operation			◎													
	Color of exhaust gas is	Black			◎		◎										
		Blue under light load						◎									
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low												◎	◎			
	When engine is cranked, interference sound is generated around turbocharger				◎												
	When engine is cranked, abnormal sound is generated around cylinder head						◎										
	High idle speed is too high													○			
	High idle speed under no load is normal, but speed suddenly drops when load is applied								○		◎	○	○				
	Engine does not pick up smoothly and combustion is irregular			◎	◎				○	○			◎				
	There is hunting from engine (rotation is irregular)								○	○	○		○	○			
	Blow-by gas is excessive				◎			◎									
Troubleshooting	Inspect air cleaner directly		●														
	Inspect air intake piping directly			●													
	When boost pressure is measured, it is found to be low		●	●	●												
	When compression pressure is measured, it is found to be low					●		●									
	Inspect valve clearance directly						●										
	Inspect fuel piping									●							
	Inspect fuel filter, strainer directly										●						
	Inspect spill port check valve directly																●
	Carry out troubleshooting according to “No-pressure feed by supply pump (*1)” in E-mode											●					
	When a cylinder is cut out for reduced cylinder mode operation, engine speed does not change												●	●			
	Inspect boost pressure sensor mount directly														●		
	Carry out troubleshooting according to “Abnormality in boost pressure sensor (*2)” in E-mode															●	
		Remedy	Clean	Correct	Replace	Replace	Adjust	Replace	Clean	Correct	Replace	Replace	Replace	Replace	Correct	Replace	Replace

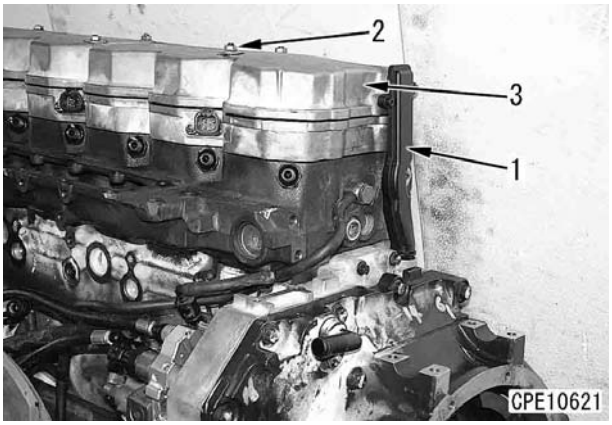
*1: Code [559/CA559] and code [2249/CA2249] in E-mode
*2: Code [122/CA122] and code [123/CA123] in E-mode

S-16 Vibration is excessive

General causes why vibration is excessive
- Defective parts (abnormal wear, breakage)
- Misalignment between engine and chassis
- Abnormal combustion

★ If abnormal noise is made and vibration is excessive, carry out troubleshooting for “S-15 Abnormal noise is made“, too.

			Causes							
			Stuck dynamic valve system (valve, rocker lever)	Worn main bearing, connecting rod bearing	Improper gear train backlash	Worn camshaft bushing	Improper fuel injection timing (abnormality in coolant temperature sensor, boost temperature sensor)	Loose engine mounting bolts, broken cushions	Misalignment between engine and devices on applicable machine side	Broken output shaft, parts in damper on applicable machine side
Questions	Confirm recent repair history									
	Degree of use of machine	Operated for long period		△		△		△		
	Condition of vibration	Suddenly increased	○							○
		Gradually increased		○		○		○		
	Non-specified oil is being used			○		○				
Check items	Metal particles are found when oil filter is drained			◎		◎				
	Metal particles are found when oil pan is drained			◎		◎				
	Oil pressure is low at low idle			○		○				
	Vibration occurs at mid-range speed							○		○
	Vibration follows engine speed				○			○	○	○
	Exhaust smoke is black		◎				○			
Troubleshooting	Inspect dynamic valve system directly		●							
	Inspect main bearing and connecting rod bearing directly			●						
	Inspect gear train directly				●					
	Inspect camshaft bushing directly					●				
	Confirm with INSITE or with monitoring function on applicable machine side						●			
	Inspect engine mounting bolts and cushions directly							●		
	When alignment is checked, radial runout or facial runout is detected								●	
	Inspect output shaft or inside of damper directly									●
		Remedy	Replace	Replace	Replace	Replace	Replace	Replace	Adjust	Replace



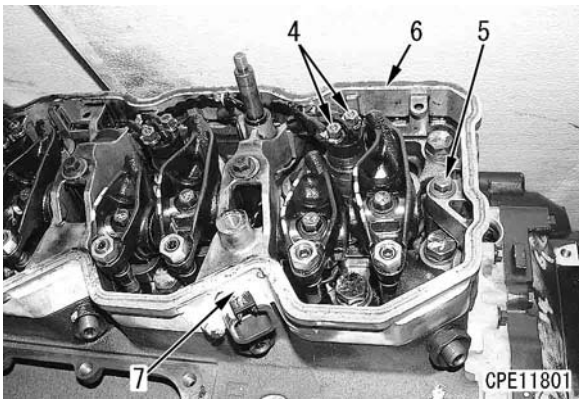
3) Remove nuts (4) of the harness from injector.

★ Harness installation position

Color of cable	Cylinder No.
White	1, 3, 5
Black	2, 4, 6

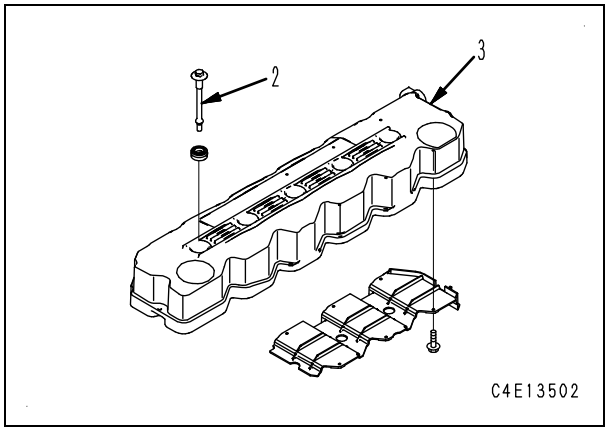
Note: No.5 and 6 cylinders are equipped with 6D107E-1 only.

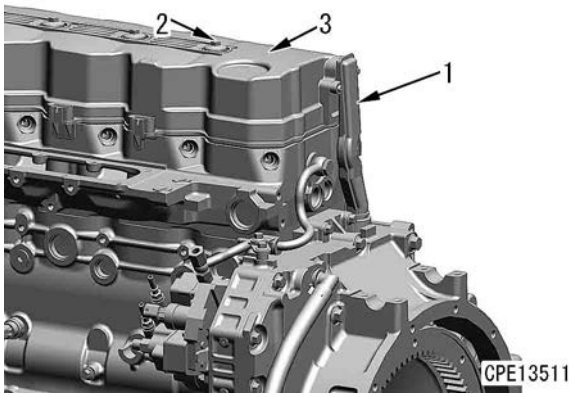
4) Remove bolt (5) and then remove rocker housing assembly (6).
★ Do not remove the injector harness connector (7) from rocker housing unless it is required.



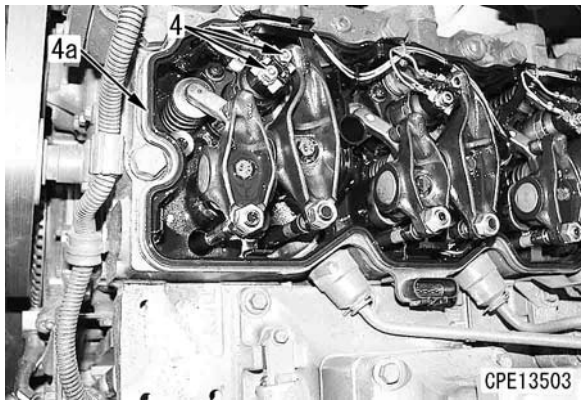
<WA380Z-6, PC200-8M0, PC200LC-8M0, PC220-8M0, PC220LC-8M0 and PC240LC-8M0 only>

1) Remove bolts (2) and then remove head cover (3) together with duct (1).
2) Remove duct (1) from head cover (3).





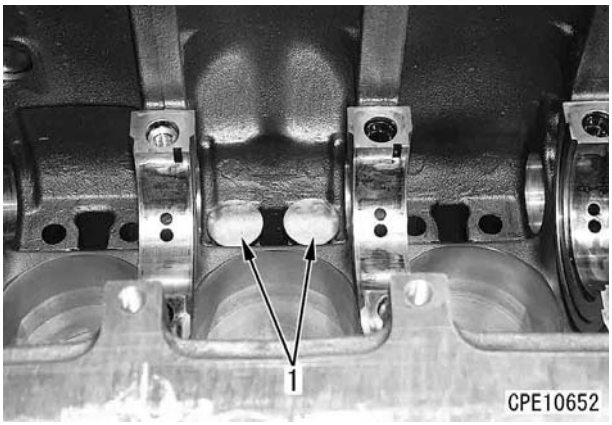
3) Remove nuts (4) of the harness from injector.
★ The injector harness and nut have no positional distinction. (Their right and left sides may be reversed)
4) Remove gasket assembly (4a).



36. Tappet

Remove tappets (1) and then mark the installation position on them.

★ When reusing the camshafts and tappets, be sure to install them in the original position.

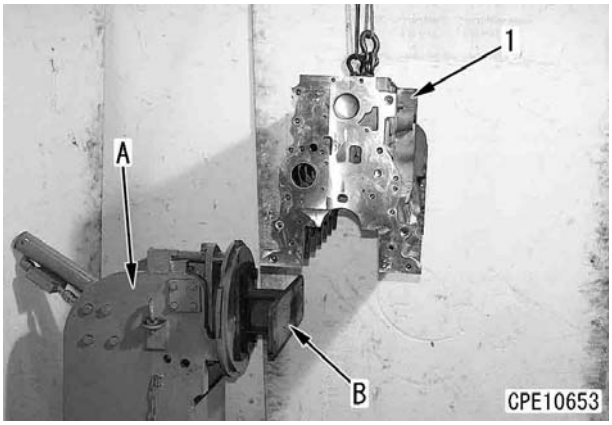


37. Cylinder block

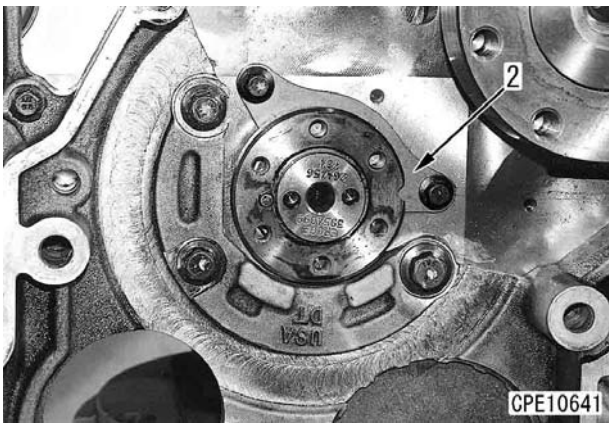
Remove cylinder block (1) from tool **A**.

Cylinder block: **100 kg (4D107E-1)**

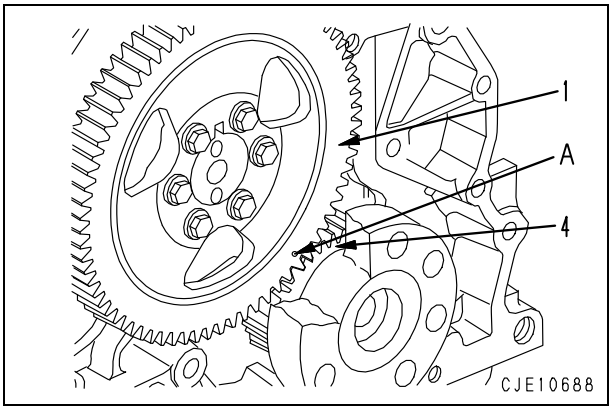
Cylinder block: **140 kg (6D107E-1)**



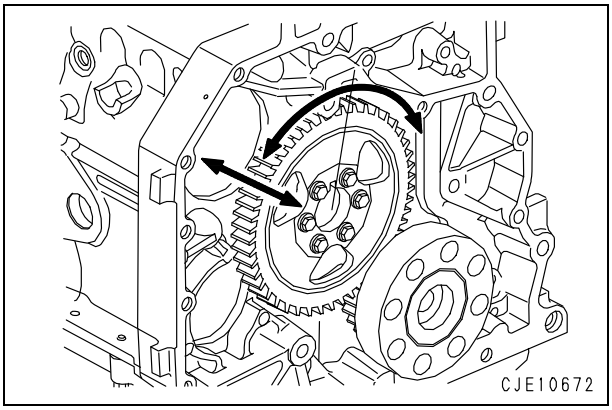
2) Install thrust plate (2).
Mounting bolt:
24 ± 4 Nm {2.4 ± 0.4 kgm}



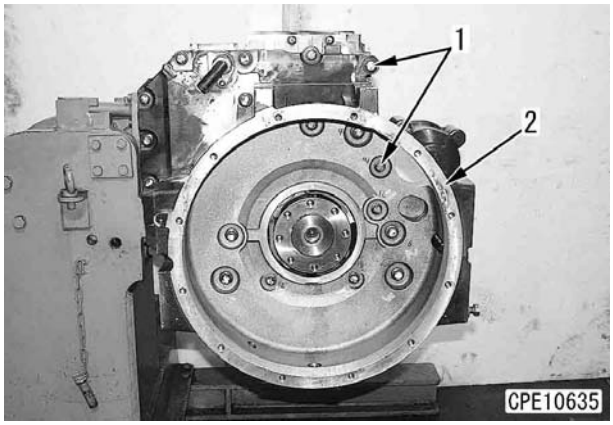
3) When installing, fit in the thrust plate to timing mark **A** on camshaft gear (1) as well as to the chamfered tooth (a single location) of crankshaft gear (4).
Mounting bolt:
36 ± 4 Nm {3.7 ± 0.4 kgm}



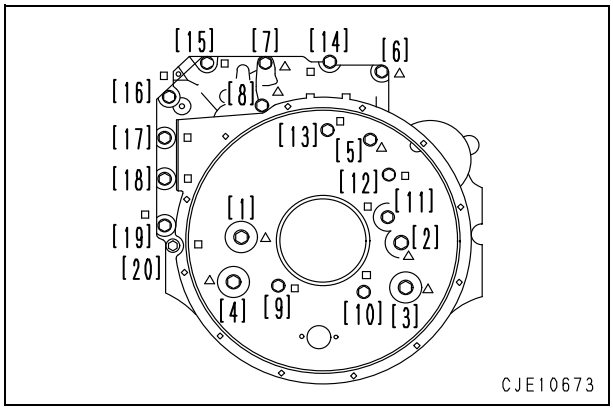
4) Measure the end play and backlash of the camshaft with a dial gauge.
★ End play: **0.10 – 0.36 mm**
● The end play is determined by thickness of the thrust plate and groove of the camshaft.
★ Backlash: **0.076 – 0.280 mm**



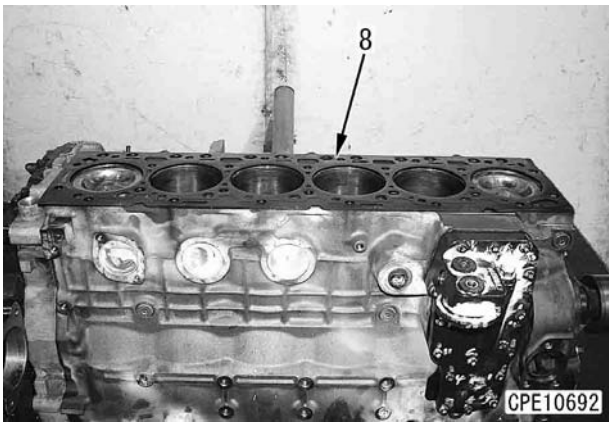
8. Flywheel housing
1) Install flywheel housing (2) using bolt (1).
★ Apply gasket sealant (LG-7) to the flanged housing installation surface as well as circumference of the mounting bolt hole. Diameter of gasket sealant line shall be 1 – 3 mm.
Flywheel housing:
Gasket sealant (LG-7)



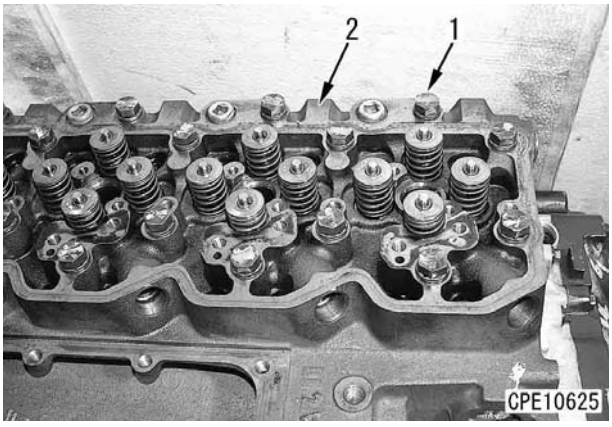
2) Tighten the mounting bolts in the numeric order [1] → [20] shown in the figure.
<All engine except for generator>
★ 2 types of bolts are used. Make sure when tightening that the specified torque is used.
1] M12:
85 ± 10 Nm {8.7 ± 1.0 kgm}
(△ mark)
2] M10:
49 ± 5 Nm {5.0 ± 0.5 kgm}
(□ mark)



3) Check that the cylinder head mounting face and inside of the cylinder are free from foreign matter and then set cylinder head gasket (8).
   ★ Make sure that the gasket is fitted in the hole on the cylinder head.

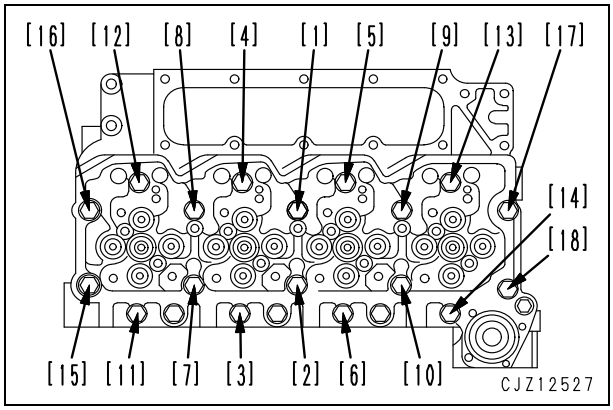


4) Set cylinder head assembly (2) on the cylinder block and then tighten it using mounting bolts (1).

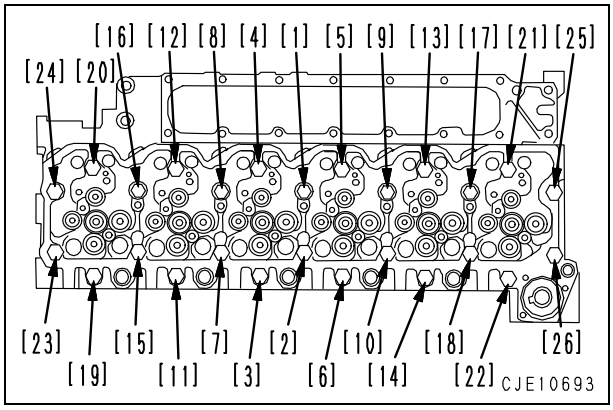


★ First, tighten the mounting bolts by 2 – 3 turns or more by hand, and then tighten them according to the following procedure.
Apply engine oil (EO15W-40) to the threaded portion and head seat of each bolt.
Mounting bolt:
★ Tighten the bolts 3 times in the order shown in the figure.
1] 90 ± 3 Nm {9.2 ± 0.3 kgm}
2] 90 ± 3 Nm {9.2 ± 0.3 kgm}
3] 90° ± 5° (When tightened with angle tightening tool J)

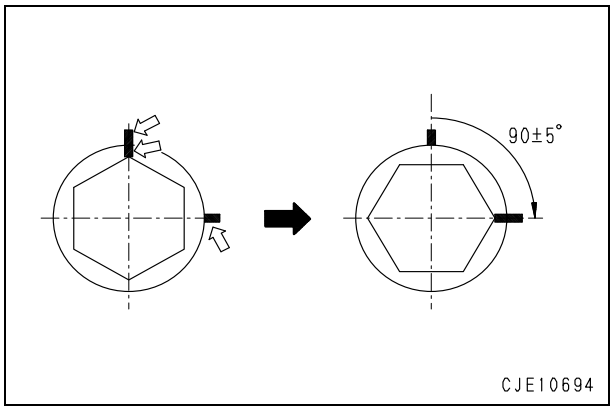
<4D107E-1>



<6D107E-1>



- When the angle tightening tool **J** is not used:
  After applying a paint marking to the cylinder head and bolt, tighten the bolt by **90° ± 5°**.

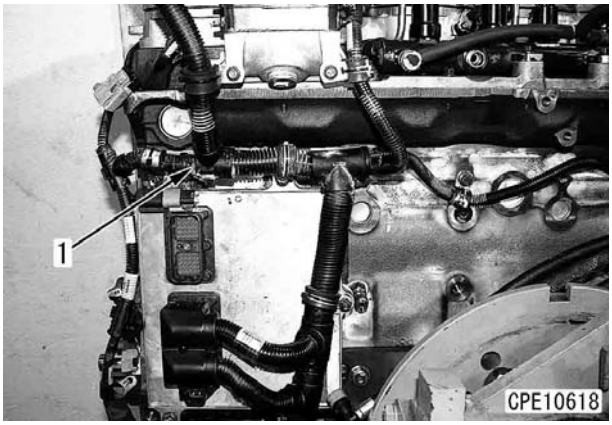


28. Harness assembly

<Other than WA380Z-6, PC200-8M0, PC200LC-8M0, PC220-8M0, PC220LC-8M0 and PC240LC-8M0>

Connect harness assembly (1) to the controller and sensor and then fix it to the engine.

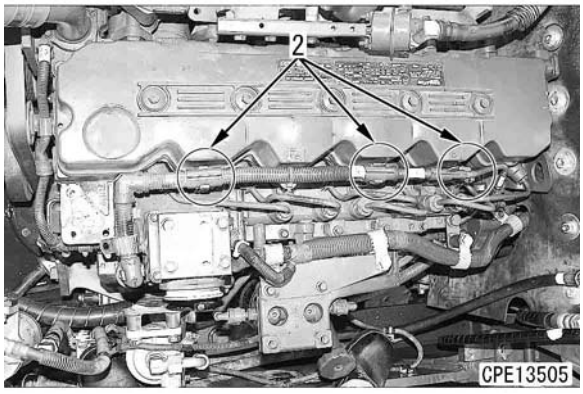
⚠ **Before connecting the harness connector, clean sands, dusts or water in the controller side connector.**

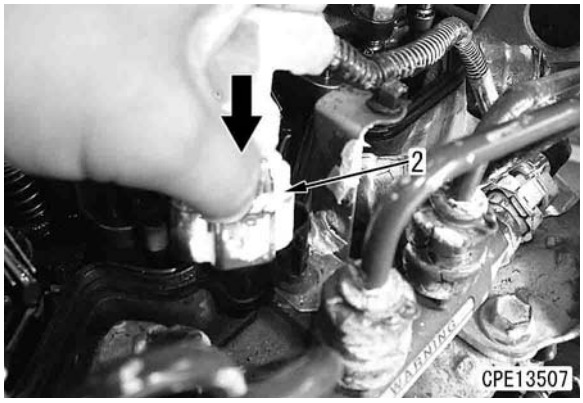


<WA380Z-6, PC200-8M0, PC200LC-8M0, PC220-8M0, PC220LC-8M0 and PC240LC-8M0 only>

Connect three connectors (2) of the injector harness.

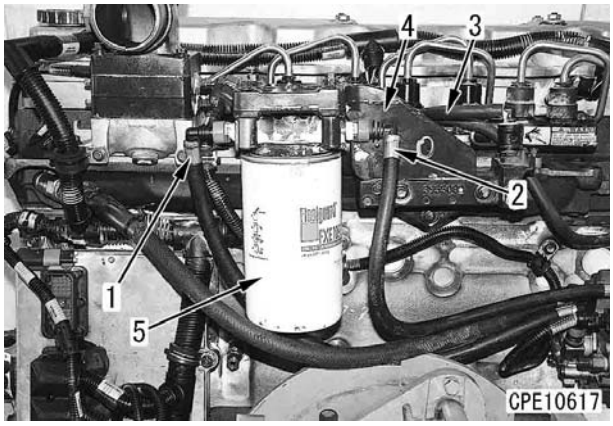
★ Push in connector (2) in the direction of the arrow until it clicks.





29. Fuel filter assembly

1) Install filter bracket assembly (4).
2) Install drain hose (3) to the filter bracket.
3) Install filter inlet hose (1) and outlet hose (2).
4) Install fuel filter (5).
   ★ As the gasket touched the filter head, tighten the fuel filter 1/2 turn to install it.



30. Exhaust manifold

1) Fit a new gasket and then install exhaust manifold (4) to the cylinder head. Tighten the mounting bolts according to the numbers shown in the figure.
   Mounting bolts tightening procedure:
   1] Tighten every bolt with **24 ± 4 Nm {2.4 ± 0.4 kgm}**.
   2] Tighten every bolt with **53 ± 6 Nm {5.4 ± 0.6 kgm}**.
   3] Tighten [1] to [4] bolts alone in the figure in this order with **53 ± 6 Nm {5.4 ± 0.6 kgm}**.

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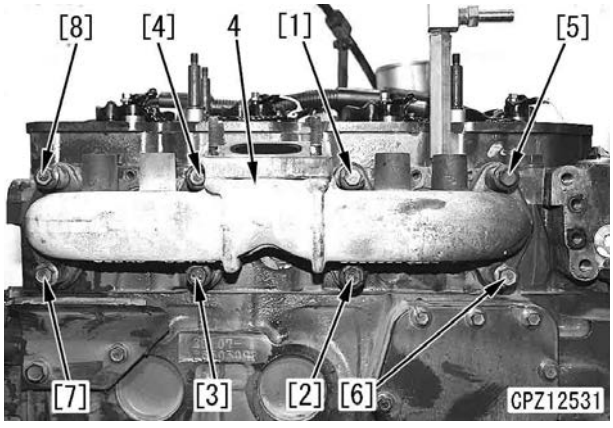
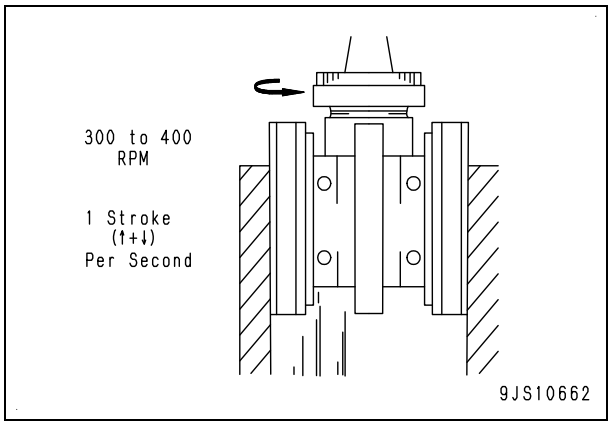
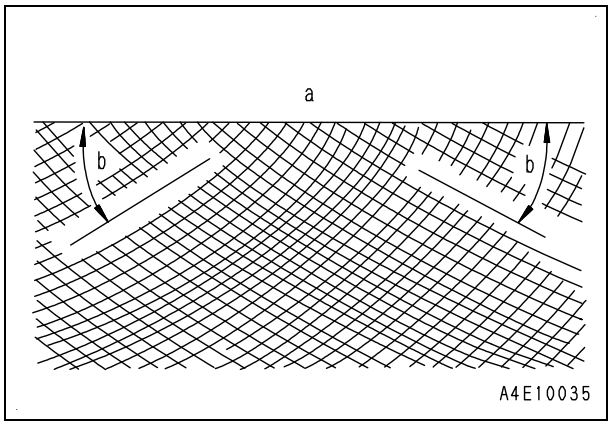


★ Hone the cylinder at a rotation speed of 300 – 400 rpm and at a pitch of 1 vertical moving cycle per second.
★ Be sure to use mixture of 50% high-quality honing oil or engine oil (EO30W) and 50% diesel fuel as lubricating oil for honing.

1) For the 1st honing pass or rough honing, use soft (high-speed cutting) silicone carbide grinding stones of 80 grits. Finish the cylinder to the final dimension by the honing work in this step.
★ Dimension after honing work:
107.490 – 107.510 mm



2) For the 2nd honing pass or finish honing, use medium-hard silicone carbide grinding stones of 285 grits.
★ Move the grinding stones at a pitch of 15 – 20 strokes to obtain proper cross hatch.
★ If the cylinder is honed accurately, cross hatch lines appear at angles of 25 – 30 degrees to the cylinder block top.



a : Cylinder block top
b : Cross hatch angle